Appeal No. 04-1018

UNITED STATES COURT OF APPEALS

for the

FEDERAL CIRCUIT

HALLIBURTON ENERGY SERVICES, INC.

Plaintiff-Appellant,

v.

WEATHERFORD INTERNATIONAL, INC.,

Defendant-Appellee,

and

BJ SERVICES COMPANY,

Defendant-Appellee.

APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF TEXAS IN CASE NO. 02-CV-01347,
JUDGE DAVID C. GODBEY

BRIEF OF DEFENDANT-APPELLEE
WEATHERFORD INTERNATIONAL, INC.

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UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

HALLIBURTON ENERGY v. WEATHERFORD, No. 04-1018

CERTIFICATE OF INTEREST

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1. The full name(s) of every party represented by me are:

WEATHERFORD INTERNATIONAL, INC.

2. The name(s) of the real parties in interest represented by me are:

WEATHERFORD INTERNATIONAL, INC.

3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party represented by me are:

WEATHERFORD INTERNATIONAL, INC.

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TABLE OF CONTENTS

I. STATEMENT OF THE ISSUE 1

II. STATEMENT OF THE CASE 2

III. WEATHERFORD'S STATEMENT OF FACTS 5

A. Background of the Relevant Technology 6

B. Halliburton's Claimed "Invention" 7

1. The Use Of Non-Metallic Materials To Improve Drillability Of Downhole Tools Was Well-Known In The Art 7

a. U.S. Patent No. 1,684,266 to Fisher et al. 8

b. The Baker fiberglass packers 8

c. Western Company's composite tool program 9

2. The Configuration Of Halliburton's Claimed "Downhole Apparatus" Was Also Well-Known In The Art 10

a. Halliburton's own metallic downhole tools employing the same dual-slip and packing configuration 11

b. Other prior art using the dual-slip configuration 12

3. Halliburton's Claimed "Downhole Tool" And "Downhole Apparatus" Are Broader Than Merely Composite Bridge Plugs And Packers 13

C. The District Court Proceedings 15

1. Halliburton's Delays In Bringing Suit And Seeking Preliminary Relief 15

2. The District Court's Order Denying Preliminary Relief 18

3. The District Court Rejects Halliburton's Reconsideration Motion 19

IV. SUMMARY OF THE ARGUMENT 21

V. ARGUMENT 25

A. Standard of Review 25

B. Halliburton's Failure To Show A Likelihood Of Success On The Merits 27

1. The District Court Properly Limited Its Preliminary Claim Construction To The Extent Necessary To Resolve Halliburton's Motions 27

2. Halliburton's Proposed Claim Construction And Invalidity Analyses Are Legally Flawed 29

C. The Prior Art Clearly Raises Substantial Questions Of Invalidity As To Each Asserted Claim 33

1. The Fisher '266 Patent Anticipates All Three Asserted Claims 34

a. "slip means ... for grippingly engaging said well bore" 37

b. "disposed on said mandrel" 39

c. "locking...engagement" 40

d. "sealing engagement" 42

2. The Baker Fiberglass Packers Also Invalidate The Asserted Claims 46

a. The Baker Packers Anticipate Claim 30 of the '468 Patent 46

b. The Baker Packers Render Claim 1 Of The '468 Patent and Claim 3 of the '540 Patent Obvious 47

D. Halliburton's Requested Relief Is Improper 52

E. The Remaining Preliminary Injunction Factors Strongly Support The District Court's Ruling 56

1. The District Court Never Addressed Halliburton's Likelihood Of Success On Infringement 56

2. Halliburton Is Not Entitled To A Presumption Of Irreparable Harm 57

a. Halliburton's Only Evidence Does Not Demonstrate Irreparable Harm 58

b. Halliburton's Dilatory Conduct And Acquiescence To Others' Infringement Refute Any Irreparable Harm 60

3. The Balance Of Hardships And The Public Interest Factors Also Favor Weatherford.. 63

VI. CONCLUSION.. 64

TABLE OF AUTHORITIES

CASES

Amazon.com, Inc. v. Barnesandnoble.com, Inc.,
239 F.3d 1343 (Fed. Cir. 2001) 25, 26, 33, 44

American Permahedge, Inc. v. Baracana, Inc.,
857 F. Supp. 308 (S.D.N.Y. 1994) 61

Amgen, Inc. v. Hoechst Marion Roussel, Inc.,
314 F.3d 1313 (Fed. Cir. 2003) 3, 19, 44, 45

Asyst Technologies, Inc. v. Empak, Inc.,
268 F.3d 1364 (Fed. Cir. 2001) 31, 38

Black & Decker, Inc. v. Hoover Service Center,
886 F.2d 1285 (Fed. Cir. 1989) 53

Caterpillar Inc. v. Deere & Co.,
224 F.3d 1374 (Fed. Cir. 2000) 38

CVI/Beta Ventures, Inc. v. Tura LP,
112 F.3d 1146 (Fed. Cir. 1997) 5

Ecolochem v. Southern California Edison Co.,
227 F.3d 1361 (Fed. Cir. 2000) 51

Ethicon, Inc. v. U.S. Surgical Corp.,
762 F. Supp. 480 (D. Conn. 1991),
aff'd, 965 F.2d 1065 (Fed. Cir. 1992) 61

Fromson v. Western Litho Plate & Supply Co.,
853 F.2d 1568 (Fed. Cir. 1988) 26, 53

Globetrotter Software, Inc. v. Elan Computer Group, Inc.,
236 F.3d 1363 (Fed. Cir. 2001) 25

Graham v. John Deere Co.,
383 U.S. 1 (1966) 50

H.H. Robertson Co. v. United Steel Deck, Inc.,
820 F.2d 384 (Fed. Cir. 1987) 63

Helifix Ltd. v. Blok-lok, Ltd.,
208 F.3d 1339 (Fed. Cir. 2000) 26

Illinois Tool Works, Inc. v. Grip-Pak, Inc.,
906 F.2d 679 (Fed. Cir. 1990) 59, 64

In re Etter,
756 F.2d 852 (Fed. Cir. 1985) 38

In re Gurley,
27 F.3d 551 (Fed. Cir. 1994) 49

Intel Corp. v. ULSI System Technology, Inc.,
995 F.2d 1566 (Fed. Cir. 1993) 25

International Communication Material, Inc. v. Ricoh Co., Ltd.,
108 F.3d 316 (Fed. Cir. 2001) 25, 28

Jack Guttman, Inc. v. Kopykake Enterprises, Inc.,
302 F.3d 1352 (Fed. Cir. 2002) .... passim

Kegel Co. v. AMF Bowling, Inc.,
127 F.3d 1420 (Fed. Cir. 1997) 32

Lewmar Marine, Inc. v. Barient, Inc.,
827 F.2d 744 (Fed. Cir. 1987) 32

National Steel Car, Ltd. v. Canadian Pacific Railway, Ltd.,
No. 03-1256 (Fed. Cir. Jan. 29, 2004) .... passim

New England Braiding Co. v. A.W. Chesterton Co.,
970 F.2d 878 (Fed. Cir. 1992) 21

Newell Cos. v. Kenney Manufacturing Co.,
864 F.2d 757 (Fed. Cir. 1988) 51

Novo Nordisk v. Genentech, Inc.,
77 F.3d 1364 (Fed. Cir. 1996) 64

Nutrition 21 v. United States,
14 USPQ2d 1244 (W.D. Wash. 1990),
aff'd, 930 F.2d 867 (Fed. Cir. 1991) 61

Nutrition 21 v. United States,
930 F.2d 867 (Fed. Cir. 1991) 57, 58, 61

Odetics, Inc. v. Storage Technology Corp.,
185 F.3d 1259 (Fed. Cir. 1999) 22, 31, 43

Polymer Technologies, Inc. v. Bridwell,
103 F.3d 970 (Fed. Cir. 1996) 55, 57, 61

Purdue Pharma L.P. v. Boehringer Ingelheim GmbH,
237 F.3d 1359 (Fed. Cir. 2001) 44, 58

Reebok International Ltd. v. J. Baker, Inc.,
32 F.3d 1552 (Fed. Cir. 1994) 59

Sandt Technology, Ltd. v. Resco Metal & Plastics Corp.,
264 F.3d 1344 (Fed. Cir. 2001) 51

Sjolund v. Musland,
847 F.2d 1573 (Fed. Cir. 1980) 51

Sofamor Danek Group, Inc. v. Depuy-Motech, Inc.,
74 F.3d 1216 (Fed. Cir. 1996) 5, 28

T.J. Smith & Nephew Ltd. v. Consolidated Medical Equipment, Inc.,
821 F.2d 646 (Fed. Cir. 1987) 60, 61, 62

University of West Virginia Board of Trustees v. VanVoorhies,
84 F. Supp. 2d 759 (D. W.Va. 2001),
aff'd, 278 F.3d 1288 (Fed. Cir. 2002) 57

Wang Laboratories, Inc. v. Mitsubishi Electronics America, Inc.,
29 USPQ2d 1481 (C.D. Cal. 1993) 62

Wenger Manufacturing, Inc. v. Coating Machinery Systems, Inc.,
239 F.3d 1225 (Fed. Cir. 2001) 30

STATUTES

35 U.S.C. § 102 2

35 U.S.C. § 103 2

35 U.S.C. § 112 30

ABBREVIATIONS

Weatherford	Defendant-Appellee Weatherford International, Inc.
BJ	Defendant-Appellee BJ Services Company
Defendants	Weatherford and BJ, collectively
Halliburton	Plaintiff-Appellant Halliburton Energy Services, Inc.
the '468 patent	Halliburton's U.S. Patent No. 5,271,468
the '540 patent	Halliburton's U.S. Patent No. 5,224,540
patents-in-suit	the '468 and '540 patents, collectively
Complaint	Halliburton's Original Complaint, filed June 27, 2002 in the U.S. District Court for the Northern District of Texas
Order	The District Court's March 4, 2003 Memorandum Opinion and Order denying Halliburton's request for a preliminary injunction
PTO	United States Patent and Trademark Office
Fisher '266 patent	U.S. Patent No. 1,684,266 to Fisher et al.
Baker fiberglass packer	Either of two fiberglass downhole tools advertised and sold by Baker Oil Tools during the 1960s
Sukup '202 patent	U.S. Patent No. 4,708,202 to Sukup et al.
Muse '366 patent	U.S. Patent No. 3,306,366 to Muse et al.
Western	The Western Company of North America
ADR	Alternative Dispute Resolution

Blue Br.	Brief of Plaintiff-Appellant Halliburton Energy Services, Inc., filed in this action on December 15, 2003
A___	Appendix page number
D___	Docket entry number
___:___	Column and line number for a patent (*e.g.*, column 6, lines 4-20 is 6:4-20) or page and line number for a transcript (*e.g.*, transcript page 307, lines 14-20 is 307:14-20)

NOTE: All emphasis in this brief has been added unless otherwise noted.

STATEMENT OF RELATED CASES

Weatherford agrees with Halliburton's Statement of Related Cases.

I. STATEMENT OF THE ISSUE

Where a preliminary injunction motion was filed with the Complaint and decided on a limited record, did the district court abuse its discretion in denying the patentee's request for preliminary injunctive relief where the Defendants raised multiple substantially meritorious challenges to the validity of each asserted claim based on prior art not before the PTO during prosecution?

II. STATEMENT OF THE CASE

Halliburton sued Weatherford and BJ Services on June 27, 2002 for alleged infringement of the '468 patent and the '540 patent. A100-04. Weatherford answered on July 29, 2002 and filed counterclaims that the two patents-in-suit are invalid and not infringed. A175-84.

Together with its Complaint, Halliburton moved for a temporary restraining order and a preliminary injunction based on claims 1 and 30 of the '468 patent and claim 3 of the '540 patent. A500-02; A1856-57. Weatherford and BJ each opposed these motions, arguing primarily that Halliburton could not establish a likelihood of success on the merits because each asserted claim of the patents-in-suit is invalid under 35 U.S.C. §102 or §103. A798-99. As support, Weatherford cited numerous patents and other prior art, much of which had not been considered by the PTO during prosecution. A804-15.

The district court held a hearing on Halliburton's motions on September 19, 2002. A45(D80). On March 4, 2003, the district court denied Halliburton's motions, concluding that Defendants had presented substantial questions regarding the validity of each asserted claim. A1-20. Specifically, the district court concluded that the Fisher '266 patent (issued in 1928) directed to an improved wooden bridge plug would anticipate each of the three asserted claims. A7-14, A19. The district court also concluded that the Baker references alone would

anticipate or render obvious claim 30 of the '468 patent, and that the Baker references combined with the Sukup '202 patent or the Fisher '266 patent would render obvious claim 1 of the '468 patent. A15-17, A19. Finally, the district court held that the Baker references together with either the Muse '366 patent or the Fisher '266 patent would render obvious claim 3 of the '540 patent. A17-19.

Realizing that significant deficiencies in its case had been exposed by Defendants and recognized by the district court, Halliburton moved for reconsideration as a poorly-disguised vehicle by which to supplement the record with new evidence allegedly showing that the Fisher '266 patent was not enabling. Halliburton's premise was that *Amgen, Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313 (Fed. Cir. 2003), had changed controlling law by shifting the burden to the patentee to establish that a cited prior art patent was not enabling. A21-22. In response, Weatherford submitted extensive evidence disproving Halliburton's belated attack on the Fisher '266 patent. A5066-80; A5097-5112.

Correctly concluding that *Amgen* had not materially changed the law in any respect relevant to Halliburton's motion, and recognizing that Halliburton had always had the burden of proving a likelihood of success, the district court denied Halliburton's motion for reconsideration on August 26, 2003. A21-25. In doing so, the district court denied Halliburton's motion for leave to file its additional

evidence, and denied Weatherford's motion to submit its rebuttal evidence as moot. A25 n.2.

Halliburton filed this appeal pursuant to 28 U.S.C. § 1292(c)(1) on September 24, 2003. A48(D108). On December 11, 2003, the district court further postponed the pending *Markman* hearing and other substantive motions until 45 days after this Court's mandate. A5149-50. Even so, some important discovery has occurred while Halliburton's preliminary injunction motion and appeal have been pending, allowing Weatherford to develop some additional defenses.

III. WEATHERFORD'S STATEMENT OF FACTS

Halliburton's Statement of Facts consists almost exclusively of attorney argument masquerading as alleged fact with few citations to the limited record, particularly when characterizing the prior art and summarizing the district court's opinion. It is apparent that Halliburton's appeal is an improper attempt to induce this Court to perform a detailed claim construction before the district court has done so, or to prejudge disputed claim construction issues in a manner that binds the district court when it conducts a *Markman* hearing on a full record. However, Halliburton's efforts are clearly misplaced.

Any claim construction reached by the district court (or by this Court) based on the existing preliminary injunction record would not be controlling in later stages of this case.[1] Hence, Halliburton's efforts to introduce facts having no basis in the record and to characterize its own view of the disputed evidence as undisputed fact are both unnecessary and improper. For that reason, Weatherford

[1] *See, e.g.*, *National Steel Car, Ltd. v. Canadian Pac. Ry., Ltd.*, No. 03-1256 (Fed. Cir. Jan. 29, 2004), slip. op. at 27 (recognizing that this Court's purpose when reviewing a preliminary injunction is not to definitively construe all terms that might be relevant at trial); *Sofamor Danek Group, Inc. v. Depuy-Motech, Inc.*, 74 F.3d 1216, 1221 (Fed. Cir. 1996) (court need not interpret a claim conclusively and finally during a preliminary injunction proceeding); *cf. CVI/Beta Ventures, Inc. v. Tura LP*, 112 F.3d 1146, 1160 n.7 (Fed. Cir. 1997) (adopting a claim construction on appeal from final judgment differing from the tentative construction this Court had accepted in an earlier appeal from a preliminary injunction involving the same patent).

sets forth the following facts based on the evidence of record that are relevant to review of the district court's Order denying Halliburton's preliminary injunction motion (which is the only issue before this Court).

A. Background of the Relevant Technology

Oil and gas wells are typically drilled thousands of feet into the earth by rotating a string of drill pipe with a drill bit attached to its lower end. A2 n.1. Over the depth of the well, the wellbore will often pass through various, discrete strata, only some of which are oil- or gas-bearing production zones.

For safety and environmental reasons, and to protect the wellbore from caving in, strings of steel pipe called "casing" are lowered into the borehole and cemented into place. A2 n.1. The casing is then perforated at the production zones so that oil and gas can flow into the casing and up to the surface. A655-56.

Over the course of a well's producing life, it may become necessary or desirable to close off certain zones, to fracture or acidize a zone to enhance flow, or to repair the cement "barrier" surrounding the casing. A659. A wide variety of downhole tools are used to perform these operations. A59(1:18-28). Many of these downhole tools share common features, such as "slips" for engaging the casing to hold the tool in place and a "packing" apparatus that seals the annular area between the tool's mandrel and the casing. A666(1:42-50). The patents-in-

suit generally relate to these "downhole tools," or "downhole apparatus," that are installed, or "set," in wellbores. A56(1:11-16).

Two common types of downhole tools are "bridge plugs," which completely close off a cross-section of the wellbore, allowing operations above the plug without disturbing the lower portion of the wellbore; and "packers," which are similar to bridge plugs but often include a valve through the mandrel to control fluid flow between the spaces above and below the packer. A56(1:52-59). Both of these types of tools can typically be removed from the wellbore if desired; but while some tools can be retrieved to the surface and possibly reused, others are removed simply by drilling through the body of the tool. A56(1:29-32).

B. Halliburton's Claimed "Invention"

1. The Use Of Non-Metallic Materials To Improve Drillability Of Downhole Tools Was Well-Known In The Art

Halliburton did not invent the concept of using non-metallic materials to improve the drillability of downhole tools. In fact, the suggestion or desirability of using non-metallic components in such tools had been well known for over sixty years before Halliburton's patent applications, as reflected in numerous patents and other prior art that were not before the PTO during the prosecution of the patents-in-suit.

a. **U.S. Patent No. 1,684,266 to Fisher et al.**

As early as 1927, the inventors of the Fisher '266 patent had already recognized that drill-out times for removing downhole tools from a wellbore could be significantly reduced by constructing the tools from non-metallic materials. The '266 patent clearly states that a key feature of the invention was improved drillability: "Another object of the invention is to provide a bridging plug which is formed of a readily destructible material so that after the plug has been seated, it will be relatively easy to remove the same for further drilling operations by a drilling tool." A1204(1:16-21).

Because composite materials technology in 1927 had not developed the materials and knowledge available to Halliburton in the late 1980s, the '266 patent discloses an easily drillable downhole tool made of wood, a material readily available in 1927. A1204(1:94-98) ("The segments 10 and the mandrel 14 are preferably formed of wood so that the plug can easily be drilled out of the casing"). The wooden components of the Fisher bridge plug are clearly "non-metallic" as the asserted claims require.

b. **The Baker fiberglass packers**

As new composite materials were developed, their strength made them an attractive choice for constructing downhole tools. In the mid-1960s, for example, Baker Oil Tools developed a packer constructed almost entirely of fiberglass.

A837(¶4); A842-44; A1079-82. Although the Baker fiberglass packers were intended to be retrievable, not permanent, they often had to be removed from the wellbore by drilling. A765-66(¶¶19-20, 22); A835(¶3). The Baker packers demonstrate that twenty-five years before Halliburton's patent applications, composite materials had already been used to construct downhole tools that could withstand the rigors of being set in a well casing.

c. Western Company's composite tool program

In the early to mid-1980s, Monty Harris and Richard Sukup at Western began developing downhole tools made mostly of non-metallic components to improve their drillability. A835. Harris and Sukup ultimately obtained U.S. Patent No. 4,708,202 on a portion of their design work. *Id.*; A660-75. The Sukup '202 patent expressly discloses the use of "synthetic resins" in downhole tool components to improve drillability. A669(8:3-6) ("[T]he present invention provides a permanent downhole tool that is readily removable by drilling in view of use of synthetic resins as the material of construction for various components in the tool.").

Western's work with composites did not end with the '202 patent. It is undisputed that Harris and Sukup actually developed and tested the components for a downhole tool made almost entirely of non-metallic materials, including a non-metallic center mandrel. Blue Br. 10. More important, Halliburton cannot

seriously dispute that over five years before its patent applications, Harris and Sukup had constructed permanent downhole tools of non-metallic materials to improve their drillability. A835(¶¶6-8). Although Halliburton has attempted to marginalize this work by describing it as "failed and abandoned" (Blue Br. 11), the Western program was hardly the failure Halliburton portrays it to be. *Id.* For present purposes, however, the district court's Order did not cite or rely upon any of Harris and Sukup's work other than the Sukup '202 patent itself, so Halliburton's strained effort to denigrate their later work is irrelevant.

2. The Configuration Of Halliburton's Claimed "Downhole Apparatus" Was Also Well-Known In The Art

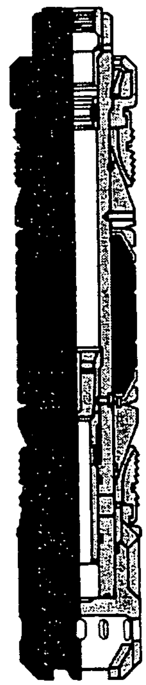
Halliburton also did not invent the "unique" configuration of the claimed composite downhole tools. Despite Halliburton's statements to the contrary, the patents-in-suit disclose and claim composite downhole tools having exactly the same configuration as prior art all-metal downhole tools. A75(3:10-16). Halliburton alleges that the downhole tools claimed in the patents-in-suit have a unique "design" or configuration, perhaps because they use a dual-slip configuration allegedly denigrated by the Sukup '202 patent. Blue Br. 13, 63. Without support, Halliburton further implies that developing its composite downhole tools was not as simple as "substituting" non-metallic components for

metallic components. *Id.* at 9-10. But the evidence shows that is all that Halliburton did.

a. Halliburton's own metallic downhole tools employing the same dual-slip and packing configuration

The patents-in-suit acknowledge that the "size and configuration of [the first packer embodiment disclosed in the patents-in-suit] is substantially the same as the previously mentioned prior art EZ Drill SV® squeeze packer." A58(5:19-24). That all-metal packer employed the same components in the same configuration as the claimed downhole tools, including dual slips. A56(1:52-56) (stating that the EZ Drill SV® squeeze packer included an upper slip support, *i.e.* a lock ring housing, as well as an upper slip wedge, a lower slip wedge, and a lower slip support mounted on a center mandrel); A1027-28 (same).

Similarly, Halliburton's prior art all-metal EZ Drill® Bridge Plug included not just dual slips but all of the same components in the same configuration as the downhole tools disclosed in the patents-in-suit. A56(1:57-59); A1028-29(¶6). In fact, as shown below, Figure 2 of the patents-in-suit depicts substantially the same tool as the EZ Drill SV® Squeeze Packer and the EZ Drill® Bridge Plug in Halliburton's 1985 "Sales & Service Catalog." *Compare* A50 *with* A1650, 1653.



EZ Drill SV*
Squeeze Packer
with pressure balanced
sliding valve

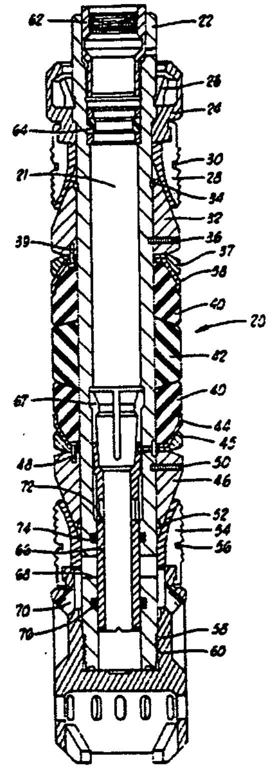


FIG. 2

Halliburton's EZ Disposal Packer, disclosed in U.S. Patent No. 4,151,875 to Sullaway (issued in 1979) (A1591-1600), also employs substantially the same configuration of components as the downhole tools of the patents-in-suit. A56(1:38-41). In particular, the '875 patent discloses the same upper and lower (*i.e.*, dual) slip configuration as disclosed and claimed in the patents-in-suit. A1592; A1594(1:45-48).

b. Other prior art using the dual-slip configuration

Additional prior art shows the same dual-slip configuration Halliburton now claims was a novel design choice. For example, U.S. Patent Nos. 2,589,506 (issued in 1947 to Morrisett) (A1558-61); 3,306,366 (issued in 1967 to Muse)

(A864-75); and 3,910,348 (issued in 1975 to Pitts) (A880-83) each disclose downhole tools including a packing element between upper and lower slip assemblies comprising a slip support, a wedge, and a slip. *Compare, e.g.*, A55 *with* A864, A1558, A1575. Halliburton chose the identical configuration of components for the downhole tools of the patents-in-suit.

Although Halliburton may have changed the shape or size of certain components when it substituted non-metallic components for the metallic components of these prior art tools, the patents-in-suit neither disclose nor claim any unique size or shape for these components. Rather, the patents-in-suit merely disclose and claim dual slip assemblies and one or more packing elements mounted around a center mandrel, a standard configuration that had been well known in the industry for over four decades.

3. Halliburton's Claimed "Downhole Tool" And "Downhole Apparatus" Are Broader Than Merely Composite Bridge Plugs And Packers

Seemingly undaunted by the voluminous prior art in this crowded field disclosing non-metallic components in downhole tools, and the equally extensive prior art disclosing the specific configurations claimed in the patents-in-suit, Halliburton nonetheless maintains that its claimed inventions are somehow novel and unique. In particular, Halliburton argues that the "patented inventions are not broadly directed to all types of packers and bridge plugs, but instead disclose and

claim embodiments that 'comprise specific design features to accommodate the benefits and problems of using non-metallic components, such as plastic.'" Blue Br. 22-23; *see also id.* at 20-21 ("The patents-in-suit disclose two types of tools, namely 'packers' and 'bridge plugs.'"). Halliburton's attempt to narrow the asserted claims *a posteriori* to avoid the prior art can only be rejected, however, because those claims are not so limited.

The asserted claims are broadly directed to a "downhole apparatus" or to wellbore processes using a "downhole tool" without further limitation. A63(15:31, 16:66). Although the patents-in-suit describe packers and bridge plugs, the specifications also repeatedly state that the invention may include other types of packing apparatus:

- "A downhole tool apparatus and methods of drilling the apparatus. ***The apparatus may include, but is not limited to, packers and bridge plugs*** utilizing non-metallic components." A49.

- "[I]n this disclosure, the downhole tool is characterized by well bore packing apparatus, ***but it is not intended that the invention be limited to such packing devices.***" *Id.* at 2:68-73.

- "[I]t will be understood by those skilled in the art that other tools may also be constructed utilizing components selected of non-metallic materials." A62(14:68-15:2).

- "In particular, the invention is not intended to be limited to squeeze packers or bridge plugs." A62(15:25-26).

These passages confirm that the patents-in-suit contemplate "a great variety of downhole tools." A56(1:18-19). Indeed, although Halliburton's original patent

application was directed solely to "packing apparatus" (*see* A1465 at ll.5-9; A1469 at ll.14-19), Halliburton broadened the invention claimed in the '468 patent by substituting "downhole tool" for "packing apparatus." *Compare, e.g.,* A1465 ll.1, 5-9 *and* A1469, ll.14-19 *with* A49 (title, abstract) *and* A56(1:12-16, 2:61-68).

Accordingly, the claim terms "downhole tool" and "downhole apparatus" are broad enough to cover virtually all downhole tools used in a wellbore, including packing and non-packing tools, permanent and retrievable tools, metallic and nonmetallic tools, and variations of such tools (*e.g.*, tools with either single or dual slips; tools with single or multiple packing elements). Thus, the component configurations and materials of virtually any prior art downhole tool are relevant to the validity of the patents-in-suit, irrespective of whether they relate to composite packers and bridge plugs; and it is disingenuous for Halliburton now to contend otherwise.

C. The District Court Proceedings

1. Halliburton's Delays In Bringing Suit And Seeking Preliminary Relief

The present dispute began long before Halliburton filed its Complaint on June 27, 2002. On September 10, 2001, after learning of Weatherford's sales of composite downhole tools, Halliburton sent Weatherford a cease-and-desist letter alleging infringement of eight Halliburton patents. A826. By that time,

Halliburton's principal competitor, Baker Hughes, had been selling composite tools similar to those accused of infringement in this case for at least three years. A832(¶¶13-15). The record does not show that Halliburton ever objected to or sought a remedy for Baker Hughes's activities. *See infra* section V.E.2.b.

In December 2001, Weatherford met with Halliburton and its outside counsel to explain why several Halliburton patents, including the patents-in-suit, are invalid. A828-29(¶¶5-6). At this meeting, Weatherford described multiple invalidating prior art references to Halliburton, including the non-metallic downhole tool invented by Monty Harris at Western in the mid-1980s. A828-29(¶6). In January 2002, Weatherford allowed Halliburton's attorneys to inspect Weatherford's composite bridge plug and to ask Weatherford personnel detailed questions about its design. A830-32. Unbeknownst to Weatherford, Halliburton interviewed Mr. Harris at length in December 2001 (A1071:25-1072:1) and took his sworn statement in March 2002 regarding the non-metallic downhole tools he had developed at Western. A1060.

Almost ten months after its cease-and-desist letter, Halliburton filed its Complaint and moved for a temporary restraining order and preliminary injunctive relief. A100. Halliburton also sought and obtained expedited briefing on its motions. A36(D8). As a result, Defendants originally had less than two business

days (and a weekend) to respond to Halliburton's motions, comprising over 25 pages of briefing and approximately 200 pages of exhibits.

Defendants immediately requested a one-week extension to allow Defendants to respond to Halliburton's papers, to allow BJ to obtain trial counsel, and to obtain local counsel. A37(D12). Because Halliburton opposed this reasonable request, Weatherford literally worked around the clock for the next three days until receiving the district court's July 1st order granting the extension. A37(D10).

Despite the gravity of Halliburton's requested relief, the time constraints compelled Weatherford to base its opposition on the defenses it had already identified—namely, invalidity over prior art that Weatherford had already uncovered. Further, the district court's 25-page limit made it impossible to address all other possible defenses while also addressing Halliburton's failure to show entitlement to a preliminary injunction in light of the other relevant factors: irreparable harm, the balance of hardships, and the public interest.

Moreover, no discovery had been taken, nor was any conducted while Halliburton's motions were pending. A5139. Consequently, Weatherford's opposition to the requested injunction was limited to the asserted patents' invalidity over the prior art. A1039 n.2. By so limiting its oppositions, Weatherford has not conceded infringement and will present other

noninfringement, unenforceability, and invalidity defenses at the appropriate time in subsequent proceedings.

2. The District Court's Order Denying Preliminary Relief

The district court's Order reflects that it did exactly what it was charged with doing at this early stage of the proceedings: it made a preliminary construction of claim terms based on the limited record before it and concluded that (1) Defendants had raised substantial questions regarding the validity of the asserted patent claims and (2) Halliburton had failed to show that Defendants' invalidity defenses lacked substantial merit. A19-20. The district court's Order does not purport to finally determine the contested issues, nor does it suggest that it has made its final construction of disputed claim terms. Rather, the Order expressly recognizes that "[a] *Markman* hearing will ultimately determine the proper construction" of the disputed claim terms. A9.

The district court clearly understood its task and the appropriate burdens presented by Halliburton's motion. Based on this Court's law, the district court correctly identified the standards for obtaining preliminary injunctive relief, the two-step process of first construing the claims and then comparing them to the prior art, and the legal requirements for proving anticipation and obviousness. A5-6. Moreover, the district court properly acknowledged the presumption of validity and Weatherford's burden of proof at trial, but recognized that in the

context of a preliminary injunction the moving party retains the burden of showing a reasonable likelihood that the validity challenge would fail. A6-7.

According to Halliburton, its motion was denied solely because the district court misconstrued the three asserted claims. Blue Br. 3. That is simply not true—the district court's detailed analysis demonstrates that Halliburton's motion was denied because Halliburton failed to establish that Defendants' invalidity defenses lacked substantial merit. A19-20. Halliburton's rejected construction of disputed claim terms does nothing to change the conclusion that the prior art of record likely anticipates or renders obvious the asserted claims of the patents-in-suit. Even to the extent that the district court's preliminary claim construction may have been incompletely explained, there were no shortcomings in its understanding of the relevance of the prior art to Halliburton's broad claims or in its decision to deny the injunction.

3. The District Court Rejects Halliburton's Reconsideration Motion

Instead of appealing the Order or simply proceeding with the merits of the case, Halliburton moved for reconsideration in an attempt to supplement the record with new declaration "evidence" purporting to show that the Fisher '266 patent was not enabled and thus could not anticipate the asserted claims. A1746-47. Halliburton's sole justification was its professed belief that the district court might have applied the "new" burden of proof this Court articulated in *Amgen*. A1746.

Halliburton offered no other basis for seeking reconsideration. Halliburton could not assert that its declarations were newly discovered evidence because Halliburton had raised the same arguments in two previous submissions to the district court. *See* A1233-34; A1718-19. Further, at the September 19, 2002 hearing, Halliburton displayed the same model allegedly embodying the Fisher patent addressed by its new declarations (A1892-94); but Halliburton never sought to submit the model or any related evidence before, during, or after that hearing.

Halliburton's decision to wait until the district court denied the injunction before attempting to rebut Weatherford's invalidity defenses was clearly improper. Not surprisingly, the district court denied Halliburton's motion for reconsideration without considering the newly submitted evidence. A21-25 & n.2. Nevertheless, Halliburton's reconsideration motion delayed final disposition of Halliburton's motion for preliminary relief by nearly six more months. Even then, Halliburton waited to file its appeal until twenty-nine days after reconsideration was denied. A48(D108).

Although Halliburton's notice stated that Halliburton was appealing both the Order and the order denying reconsideration (A5147), Halliburton's opening brief neither defends its reconsideration motion nor challenges its denial. Hence, Halliburton has waived any challenge to the district court's order denying reconsideration.

IV. SUMMARY OF THE ARGUMENT

Given that a preliminary injunction is an extraordinary remedy and that this Court's review of a district court's denial of a preliminary injunction motion is correspondingly narrow, Halliburton provides no reason why the district court's denial of Halliburton's motion filed at the outset of this case should be reversed. As the district court recognized, Weatherford presented highly material prior art that was not considered by the PTO during prosecution of the asserted patents and that raised substantial questions regarding the invalidity of Halliburton's claims, which are broadly directed to wellbore processes or downhole apparatus containing non-metallic components. As explained in *New England Braiding Co. v. A.W. Chesterton Co.*, 970 F.2d 878, 883 (Fed. Cir. 1992), a district court cannot be held to have erred in deciding that a patentee did not make a sufficient showing of likelihood of success where the evidence of invalidity raises a substantial question.

While Halliburton is apparently hoping that this Court will use this appeal to make definitive claim construction rulings based on the limited record containing no discovery at all, the district court properly recognized that a *Markman* hearing will ultimately decide the meaning of disputed claim terms, and this Court's precedent confirms that this is neither the time nor the place for a conclusive claim construction. Indeed, under this Court's recent decision in *National Steel Car* , the district court's preliminary claim construction need not even be reviewed. Because

Halliburton's only complaint is that the district court's preliminary claim construction causes the claims to read on prior art, the district court's conclusion that the claims are likely to be anticipated or obvious in view of that prior art cannot possibly be an abuse of discretion.

In any event, the district court properly rejected Halliburton's proposed claim construction. Contrary to Halliburton's premise, nothing in the specifications links all of the components of the structure allegedly comprising the claimed "slip means" to the claimed function of "grippingly engaging" the wellbore when in a set position. As the district court discerned, at least the "slip support" and the "retaining means" play no role in performing that specific function. Moreover, Halliburton's separate attempt to convert the individual components recited as comprising the "slip means" into distinct claim limitations violates this Court's teaching in *Odetics*, and thus provides no basis for distinguishing the prior art. Finally, Halliburton further ignores that its claims can be anticipated by prior art structure that is at least equivalent to the overall corresponding structure in its specifications.

While all prior art interpreted and relied upon by the district court cannot be summarized here, the district court easily and correctly concluded that the Fisher '266 patent (issued in 1928) disclosed a wooden bridge plug with dual slips that anticipated all of the asserted claims and provided a clear suggestion in the art to

construct downhole tools using easily drilled materials. The district court also correctly concluded that the Baker fiberglass packers disclosed a nonmetallic downhole tool with dual slips that, alone or combined with Fisher or other prior art, would independently invalidate the asserted claims.

Halliburton belatedly tried on reconsideration to show that Fisher's disclosed "sealing means" did not seal and that the Fisher patent was thus non-enabling. However, the district court correctly rejected both that motion and the "new" evidence, leaving Halliburton with only unsupported argument that Fisher "inherently" leaks. Simply put, Halliburton completely failed to meet its burden to show that Weatherford's multiple invalidity defenses lacked substantial merit.

Even if this Court were to disagree with some aspect of the district court's preliminary claim construction or conclusions, Halliburton's requested remedy should be rejected. In light of this Court's decision in *Guttman*, it is difficult to understand how Halliburton could ask this Court to direct the entry of a preliminary injunction on this record. As explained therein, not only is it for the district court to evaluate and balance all of the relevant factors in the first instance, but that instruction is even more compelling here because the parties have exchanged discovery since the district court's Order and because Weatherford has developed additional affirmative defenses that would be highly relevant to any further proceedings on remand.

Finally, even if this Court accepts Halliburton's unprecedented suggestion to evaluate in the first instance the parties' showings on the relevant factors other than the single invalidity factor relied upon by the district court, the evidence provides ample alternative grounds on which to affirm the denial of Halliburton's motion for preliminary injunctive relief. Although the district court did not reach those grounds, the existence of irreparable harm, the balance of hardships, and the public interest factors certainly cannot be resolved in Halliburton's favor, and actually tip well in favor of Defendants. Accordingly, the district court's Order denying Halliburton's requested preliminary injunction should be affirmed.

V. ARGUMENT

A. Standard of Review

A preliminary injunction is a "drastic and extraordinary remedy that is not to be routinely granted." *Intel Corp. v. ULSI Sys. Tech., Inc.*, 995 F.2d 1566, 1568 (Fed. Cir. 1993). Accordingly, "[t]he standard of review of a district court's denial of a preliminary injunction motion is narrow." *Int'l Communication Material, Inc. v. Ricoh Co., Ltd.*, 108 F.3d 316, 318 (Fed. Cir. 2001). Such a ruling should be reversed "only upon a showing that the court abused its discretion, committed an error of law, or seriously misjudged the evidence." *Globetrotter Software, Inc. v. Elan Computer Group, Inc.*, 236 F.3d 1363, 1367 (Fed. Cir. 2001).

To obtain a preliminary injunction, Halliburton had the burden of showing: (1) a reasonable likelihood of success on the merits; (2) irreparable harm; (3) that the balance of hardships tips in its favor; and (4) that an injunction would serve the public interest. *Jack Guttman, Inc. v. Kopykake Enters., Inc.*, 302 F.3d 1352, 1356 (Fed. Cir. 2002). Although a district court may not grant a preliminary injunction without analyzing all four factors, it may deny an injunction based on a patentee's failure to show any one of the factors, "especially either of the first two." *Id.*; *see also Amazon.com, Inc. v. Barnesandnoble.com, Inc.*, 239 F.3d 1343, 1350 (Fed. Cir. 2001) ("a movant cannot be granted a preliminary injunction unless it establishes *both* … likelihood of success on the merits and irreparable harm").

The scope of this Court's review on appeal is necessarily limited to the district court's findings and conclusions on the preliminary injunction factors. *Fromson v. Western Litho Plate & Supply Co.*, 853 F.2d 1568, 1570 (Fed. Cir. 1988) ("[o]bviously, a finding not made cannot be reviewed"). If a defendant "raises a substantial question concerning either infringement or validity, *i.e.*, asserts an infringement or invalidity defense that the patentee cannot prove 'lacks substantial merit,' the preliminary injunction should not issue." *Amazon.com*, 239 F.3d at 1350. Here, without addressing any of the other relevant factors, the district court denied Halliburton's motion based solely on its conclusion that Halliburton failed to demonstrate a likelihood of success on the merits because Defendants had raised "a substantial question regarding the validity of relevant claims of the patents-in-suit." A19.

With regard to validity, a patentee seeking a preliminary injunction "must present a clear case supporting the validity of the patent-in-suit." *Amazon.com*, 239 F.3d at 1359. In contrast, a defendant is not required to make out an actual case of invalidity to defeat a preliminary injunction. *Id.* ("Vulnerability is the issue at the preliminary injunction stage, while validity is the issue at trial. The showing of a substantial question as to invalidity thus requires less proof than the clear and convincing showing necessary to establish invalidity itself."); *see also Helifix Ltd. v. Blok-lok, Ltd.*, 208 F.3d 1339, 1351-52 (Fed. Cir. 2000) (holding that conflicting

evidence over allegedly anticipatory prior art precluded a preliminary injunction even if summary judgment of invalidity was not warranted). As shown herein, Defendants established that the asserted claims are more than vulnerable—they are truly hanging on by a thread.

B. Halliburton's Failure To Show A Likelihood Of Success On The Merits

1. The District Court Properly Limited Its Preliminary Claim Construction To The Extent Necessary To Resolve Halliburton's Motions

Because preliminary injunction motions are typically decided on an incomplete record, district courts have significant discretion in resolving them. Here, the district court recognized that it was not making its final claim construction when resolving Halliburton's motion. A9 (noting that "[a] *Markman* hearing will ultimately determine the proper construction of the term 'slip means'"). Given the very early stage of this case, that is exactly what this Court's precedent required. *See, e.g.*, *Guttman*, 302 F.3d at 1361 ("[d]istrict courts may engage in a rolling construction").

Indeed, Halliburton urged the district court not once, but twice, to follow that very procedure, arguing that "a court is not required to interpret claims 'conclusively and finally' during a preliminary injunction proceeding." A897; *see also* A1217. Now, because Halliburton is dissatisfied with the district court's preliminary claim construction, it invites this Court to perform the more detailed

and conclusive claim construction that it twice encouraged the district court to avoid. This Court should decline Halliburton's invitation to render an advisory opinion based on the present record so as to prejudice the upcoming *Markman* hearing. *See Int'l Communication*, 108 F.3d at 318-19 ("We do not regard it as our function ... to review as if from final judgment the district court's tentative construction.").

A preliminary claim construction in this case was appropriate because the parties had conducted no formal discovery whatsoever. *See* A5139. In *International Communication*, this Court held that a district court did not abuse its discretion by deferring its final claim construction where there were substantial open issues, and further declined to definitively construe the claim on appeal in light of the ongoing discovery and open issues. 108 F.3d at 318-19; *see also Sofamor*, 74 F.3d at 1221 (a district court is not obligated "to conclusively interpret the claims at an early stage in a case").

More recently, this Court explained in *National Steel Car* that there was no need to review a district court's preliminary claim construction during a preliminary injunction appeal because this Court's task is only to determine whether the district court correctly concluded whether the defenses lacked substantial merit, not to definitively construe all claim terms that might be relevant at trial. *See National Steel Car*, slip op. at 27. In *National Steel Car*, the district

court granted a preliminary injunction, which this Court reversed due to a substantial obviousness challenge despite accepting the district court's preliminary construction. *Id.* at 36. That analytical approach should apply equally, if not more so, where a district court has exercised its discretion to deny preliminary relief.

If so, *National Steel Car* provides a sufficient basis on its own for affirming the district court's denial of the preliminary injunction in this case. As its central premise, Halliburton declares that the district court gave the asserted claims "impermissibly broad constructions that read on the prior art." Blue Br. 42. If *National Steel Car* means that the district court's preliminary claim construction should be accepted for purposes of this interlocutory appeal, Halliburton has conceded not only that substantial questions of invalidity exist, but also that the asserted claims would be invalid. No preliminary injunction could properly be granted based on invalid claims.

2. Halliburton's Proposed Claim Construction And Invalidity Analyses Are Legally Flawed

Even if this Court ignores Halliburton's concession that its claims are invalid under the district court's preliminary claim construction, this Court should reject Halliburton's proposed claim construction and its characterizations of the prior art. First, Halliburton presented the district court with nothing remotely resembling the analyses and assertions that it now presents to this Court. More important,

Halliburton's claim construction and invalidity analyses are contrary to §112, ¶6 and this Court's case law.

The '468 patent specification states that "[t]he slip means may comprise a wedge engaging a plurality of slips with a slip support on the opposite side of the slips from the wedge." A57(3:25-27). The corresponding sentence in the '540 patent specification states that "[t]he slip means comprises a slip wedge positioned around the center mandrel, a plurality of slips disposed in an initial position around the mandrel and adjacent to the wedge, retaining means for holding the slips in the initial position, and a slip support on the opposite side of the slips from the wedge." A75(3:29-34). According to Halliburton, those passages mean that the "slip means" of the '468 patent includes all three listed components, while the "slip means" of the '540 patent includes all four listed components. *See* Blue Br. 23. Clearly, however, the district court did not agree "for purposes of this motion." A9.

Contrary to Blue Br. 47, nothing in the sentences cited by Halliburton links any of the listed components of the "slip means" to the specific function recited in the claims. Merely reciting structure as potentially comprising a means term is not the same as directly linking that structure to the specific function recited for that means term in a particular claim. *See Wenger Mfg. Inc. v. Coating Mach. Sys., Inc.*, 239 F.3d 1225, 1232-33 (Fed. Cir. 2001). Unlike Halliburton's construction,

the district court's preliminary construction fully complies with this Court's instruction in *Asyst Technologies, Inc. v. Empak, Inc.*, 268 F.3d 1364, 1370 (Fed. Cir. 2001) that "[s]tructural features that do not actually perform the recited function do not constitute corresponding structure and thus do not serve as claim limitations."

While the district court may not have fully explained its preliminary construction of "slip means," the court clearly concluded that the slips themselves were structure needed to perform the recited function of "grippingly engaging said well bore when in a set position" but that the "slip support" in each specification and the "retaining means" in the '540 specification play no role in performing that recited function. A10-11 (concluding that "[a] slip support on the opposite side of the slips from the wedge, therefore, is not a necessary element of "slip means"). Because the '468 patent discloses that only the slips, after being wedged into position by the wedges (A62(13:29-36)), are the structure that grippingly engages the wellbore when the tool is in the set position (A62(13:36-38)), the district court did not abuse its discretion by excluding at least the slip supports from the structure corresponding to the "gripping engagement" function of the "slip means."

Moreover, Halliburton's proposed construction separately runs afoul of *Odetics, Inc. v. Storage Technology Corp.*, 185 F.3d 1259, 1268 (Fed. Cir. 1999), where this Court explained that "[t]he individual components, if any, of an overall

structure that corresponds to the claimed function are not claim limitations. Rather, the claim limitation is the overall structure corresponding to the claimed function." Trying to avoid the prior art, Halliburton subdivides the overall structure corresponding to the "slip means" into the separate components listed, and then attacks each prior art device as not containing those specific components. Blue Br. 55. Thus, in addition to failing to exclude components such as the slip support or the retaining means that do not perform the recited function of "grippingly engaging" the wellbore, Halliburton only offers an erroneous component-by-component comparison with the prior art.

Halliburton's assertions also ignore that anticipatory prior art will include structure equivalent to that disclosed in its specifications for performing the recited functions. *See Lewmar Marine, Inc. v. Barient, Inc.*, 827 F.2d 744, 747 (Fed. Cir. 1987) (that which literally infringes if later, anticipates if earlier). Just as a "means-plus-function" limitation is literally infringed by an accused product containing structure equivalent to the structure disclosed in the specification for performing the recited function, a "means-plus-function" limitation is anticipated by prior structure that is equivalent to the disclosed structure. *See, e.g., Kegel Co. v. AMF Bowling, Inc.*, 127 F.3d 1420, 1430 (Fed. Cir. 1997) (means-plus-function limitation would be anticipated by prior art device containing an equivalent to the claimed means). Halliburton's brief never addresses the possibility of anticipation

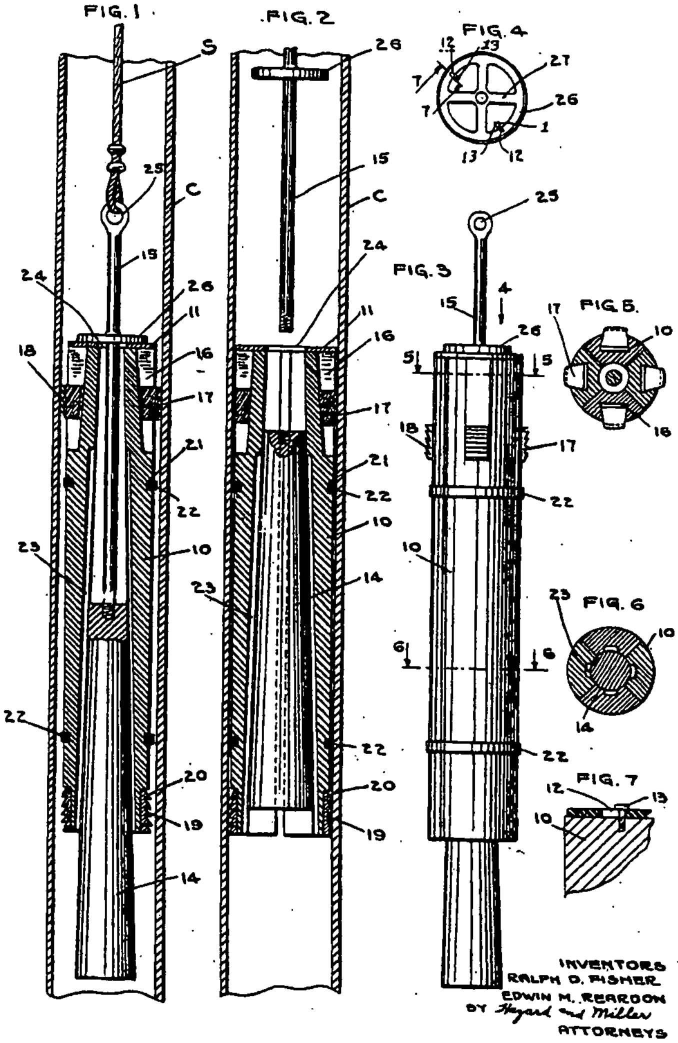
by "equivalent" structure, whether on a "component-by-component" basis or an "overall structure" basis.

Finally, Halliburton's factual assertions are either contrary to the district court's preliminary findings, wholly unsupported, or newly offered in this Court. *See, e.g.*, *Amazon.com*, 239 F.3d at 1358 (explaining that a district court's determinations as to the meaning of prior art references and what they teach are factual questions reviewed for clear error). While repeatedly advancing its own views as to what the Fisher, Baker, and Sukup references allegedly do not disclose or suggest (Blue Br. 55-65), Halliburton neither acknowledges its burden nor attempts to show clear error in the district court's explicit and implicit findings regarding the content and teachings of the prior art.

C. The Prior Art Clearly Raises Substantial Questions Of Invalidity As To Each Asserted Claim

Under a proper view of the applicable law and the standards of review, there should be no question that the district court correctly concluded that the prior art Weatherford presented in opposition to Halliburton's motions raised very substantial questions as to the validity of the asserted claims of the patents-in-suit.

1. The Fisher '266 Patent Anticipates All Three Asserted Claims



As illustrated above, the Fisher '266 patent generally discloses a wooden bridge plug with slips above and below the packing. A1203. The district court correctly found that the Fisher '266 patent likely anticipates each of the three claims asserted in Halliburton's preliminary injunction motion. A12. For the Court's convenience, the claim charts Weatherford provided to the district court

comparing the Fisher '266 patent to the asserted claims appear in the Joint Appendix and are referenced below.

With respect to claim 1 of the '468 patent, as shown in Weatherford's claim chart at A1200, the district court properly found that the Fisher patent discloses each step of the claimed method. A11. The Fisher patent discloses construction of a downhole tool having a wooden (i.e. nonmetallic) center mandrel 14 and slips 17, 19 disposed around the mandrel (A1204(1:94-98)) that grippingly engage the wellbore when set. A1205(2:37-81). The Fisher patent also clearly discloses positioning the tool in engagement with the wellbore. The engagement is "locking" because once the slips are set the tool cannot be moved up or down in the wellbore. *Id.* The engagement is "sealing" because the rubber rings 22 "engage the casing and are compressed, thus forming a packer or seal to prevent the leakage of fluid between the exterior surface of the segments **10** and the casing." A1205(2:68-73). Finally, the Fisher patent plainly discloses the step of drilling the tool out of the wellbore by observing that drillout is facilitated by constructing the tool of wood. A1205(2:94-98). Accordingly, the district court was correct to find that the Fisher patent likely anticipates claim 1 of the '468 patent.

As shown in Weatherford's claim chart at A1201, and as the district court found, the Fisher patent also discloses every limitation of claim 30 of the '468

patent. A9-11. As explained above, Fisher discloses a downhole tool for use in a wellbore. The tool includes a non-metallic center mandrel 14 and wooden segments 10 with slips 17, 19 disposed thereon. The slips grippingly engage the wellbore when in the set position. Accordingly, the district court was correct to conclude that claim 30 is likely anticipated by the Fisher patent.

The district court also correctly found that the Fisher patent likely anticipates claim 3 of the '540 patent as summarized in Weatherford's claim chart at A1201-02. A11. As the court found, the Fisher patent discloses a downhole tool that includes a center mandrel 14 and slip means and packing means disposed around the mandrel. A11-12. When the tool is set, the slip means (slips 17, 19, segments 10 and mandrel 14) grippingly engage the wellbore above and below the packing means, and the packing means (ring 22) sealingly engages the wellbore. A11-12. The slip means includes segments 10 and mandrel 14, each of which is nonmetallic. A12. Accordingly, the Fisher '266 patent discloses every limitation of claims 1-3 of the '540 patent and likely invalidates those claims.

Nevertheless, despite the virtually unambiguous correspondence between the device disclosed in the Fisher '266 patent and the limitations of the asserted claims demonstrated by Weatherford's claim charts, Halliburton insists that if the district court had not misconstrued several limitations, it would have concluded that Weatherford's validity challenges lacked substantial merit. However, it is

Halliburton's attacks on the district court's analysis of Fisher that are entirely without merit.

a. "slip means ... for grippingly engaging said well bore"

The district court interpreted the "slip means" limitation to include at least the slips themselves, which perform the recited function of "grippingly engaging said well bore when in a set position", but not to require a "slip support" (or, in the '540 patent, a "retaining means") as Halliburton urged. A10-11. Neither of the latter components has anything to do with grippingly engaging the well bore. Hence, the district court correctly found that the Fisher patent discloses the "slip means" of '468 claim 30 and '540 claim 3.

To the extent that corresponding structure for performing the stated function of the "slip means" includes a wedge in addition to the slips, as the district court concluded (A11-12), the Fisher '266 patent contains structure corresponding to or equivalent to the disclosed wedge as well. Referring to the figure above, the '266 patent discloses the use of a wooden "cone" (mandrel 14), as well as a conical cross-section in the grooves 16 behind the slips, that wedge the lower and upper slips respectively into engagement with the wellbore as the wooden bridge plug is set. A1203, A1205(3:51-68).

As previously outlined, the district court properly rejected Halliburton's proposed construction of "slip means" because it directly conflicts with this

Court's decisions in *Asyst* and *Odetics*. Because "[s]tructural features that do not actually perform the recited function do not constitute corresponding structure and thus do not serve as claim limitations", *Asyst,* 268 F.3d at 1370, the district court correctly excluded the "slip supports" from the structure corresponding to the "gripping engagement" function of the "slip means" in the asserted claims. Hence, Halliburton's arguments regarding the alleged absence of slip supports on the opposite side of the slips from the wedges cannot prevent the Fisher '266 patent from anticipating.

Moreover, Halliburton violates *Odetics* by dissecting the structure listed in the specifications as allegedly corresponding to the "slip means" into unclaimed individual components and treating them as claim limitations. *Cf. Caterpillar Inc. v. Deere & Co.*, 224 F.3d 1374, 1380 (Fed. Cir. 2000). In *Caterpillar*, the accused structure's additional unclaimed functions and its advantages over the disclosed structure were irrelevant to infringement. *Id.* at 1380. Just as unclaimed functions or advantages in a later device do not avoid infringement, unclaimed functions or advantages of a claimed invention compared to an earlier device cannot avoid anticipation.[2]

2 Similarly, Halliburton's attempts to detract from Fisher's clear teaching by suggesting that it was a "paper patent" or because there is no evidence that device was made or sold 75 years ago (Blue Br. 33) are entirely irrelevant. *See In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985) (even obsolete references constitute prior art for all that they teach).

In short, Halliburton's proposed construction violates one or more of principles set forth in this Court's controlling precedents, and the district court was right to reject it. Finally, even if analyzed without regard to the defects in Halliburton's proposed claim construction, the asserted patent claims would still be invalid. As shown in section V.C.2 below, the Baker fiberglass packers, either alone or in combination with the Fisher, Muse, or Sullaway patents, disclose or suggest every element of the asserted claims, including the additional "slip support" component that Halliburton insists must be present. Accordingly, even if the district court had adopted Halliburton's construction of "slip means", Weatherford's challenges to the validity of the patents-in-suit remain sufficiently substantial to justify denying Halliburton's motions for preliminary relief.

b. "disposed on said mandrel"

The prosecution history of the patents-in-suit confirms that the district court correctly concluded that the slip means and packing means did not need to be physically attached to the mandrel to be "disposed on" it. A14. Although Halliburton again alleges error (Blue Br. 50-52), Halliburton made the same argument to the PTO during prosecution, *i.e.*, that "disposed on" required direct contact between the slip means and the mandrel, A1523, but the examiner expressly decided that the "packing means" need not be in contact with the mandrel to be "on" it. A1533.

Because Halliburton failed to rebut the examiner's statement or otherwise convince the examiner, Halliburton acquiesced to the broader interpretation of the phrase "disposed on." Like the district court, this Court should not permit Halliburton to rely on rejected prosecution arguments to redefine the claims to avoid the broader construction mandated by the prosecution history. Consequently, the district court correctly found that in the Fisher patent, the slips 17, 19 and packing means 22 are "disposed on" the mandrel 14, even though they are in contact with the wooden segments 10 that in turn touch the mandrel. A14.

c. "locking...engagement"

As the district court found, the Fisher '266 patent also discloses that the upper and lower slips "grippingly engage the wellbore" when the tool is set such that the tool is positioned in "locking engagement" with the wellbore as provided in claim 1 of the '468 patent. A8. Halliburton apparently contends that "locking engagement" involves "the application of opposing axial forces imparted by the slip assemblies above and below the packing element and by the packing element." Blue Br. 53-54. However, the Fisher '266 patent plainly discloses that in the set position such "opposing axial forces" are applied through the upper and lower slips' oppositely directed teeth. *See* A1205(2:3-12) ("These [upper] slips have upwardly directed teeth 18, which, when they engage the casing C, will prevent upward movement of the plug within the casing. Each of the segments 10 has a

stationary slip 19 secured to its lower end, these slips being provided with downwardly directed teeth 20 which, when they engage the casing, will prevent downward movement of the plug."); A1205(2:51-68, 125-27) ("The plug is held stationary in the casing against movement in either upward or downward directions").

To the extent Halliburton separately contends that "locking engagement" means "fixed in place and can only be removed by drilling" (Blue Br. 54) so as to exclude retrievable tools, the Fisher device was designed to be only drillable, not retrievable. When the Fisher plug is set, the metal draw bar 15 is pulled free of the wooden mandrel 14 by stripping the threaded connection between them. A1205(2:81-90). This destroys the threads on the mandrel, making it impossible to retrieve the plug by inserting a new draw bar and attempting to manipulate the mandrel. Moreover, the Fisher inventors clearly contemplated drilling for removing their tool. *See, e.g.*, A1204(1:16-21) ("Another object of the invention is to provide a bridging plug *which is formed of a readily destructible material* so that after the plug has been seated, *it will be relatively easy to remove the same for further drilling operations by a drilling tool*."); A1205(2:123-25). No other method of removing the tool is described.

Although Halliburton argues that the "locking engagement" limitation was added during prosecution to distinguish the claims from prior art, A1222-23, the

Fisher patent was not a reference of record. The reference being distinguished, U.S. Patent No. 4,858,687, disclosed a "wiper plug" set with rubber blades that was designed to be pumpable through the wellbore. A1638-39. In contrast, the Fisher patent clearly discloses positioning a downhole tool into "locking engagement" with the wellbore.

d. "sealing engagement"

The district court also correctly found that the bridge plug in the Fisher '266 patent would satisfy the "sealing engagement" limitation in claim 1 of the '468 patent as well as the "packing means ... for sealingly engaging" limitation in claim 3 of the '540 patent. A8, A11. The Fisher patent states that the packing ring 22 seals the space between the wellbore and the plug, and also that it fills in the small gaps formed by expansion of the segments 10. A1205-06(2:128-3:2) (noting that the plug "carries a *sealing means* which will prevent leakage *either between the segments 10 and the casing C, or between the sides of adjacent segments* which are separated slightly when the segments are expanded."). Thus, Fisher expressly acknowledges the alleged leaking problem cited by Halliburton and describes a "sealing means" that solves the problem.

Fisher's packing ring 22 thus performs the same function as the "packing means" of claim 3 of the '540 patent using the same or equivalent structure—*i.e.*, an elastomeric annular seal. Although Halliburton contends that the corresponding

structure disclosed in the '540 patent for performing the "sealingly engaging" function is a three-element packer that is axially compressed and radially expanded when the tool is set (Blue Br. 49-50), Halliburton ignores that the Fisher plug's packer 22, which is radially expanded by the mandrel rather than by axial compression, achieves the identical sealing function in substantially the same way to achieve substantially the same result. *See Odetics*, 185 F.3d at 1267.

The district court correctly found that the "sealing engagement" limitations do not require perfectly sealing the wellbore. A13. To borrow Halliburton's phrase, such a requirement would violate the laws of physics. Although some of Halliburton's disclosed embodiments purportedly can withstand pressures of up to 5,000 psi (A58(6:27-34)), any downhole device will leak to some extent under sufficiently high pressure. Moreover, none of the asserted claims requires a minimum pressure rating or contains any performance criteria, and such limitations cannot be read into the claims from the specification. If Halliburton were correct that a downhole tool such as the Fisher plug lacks "sealing engagement" if it leaks at all, such an inflexible standard would compel a conclusion that Halliburton's claims themselves could not possibly be enabled.

Halliburton offered ***no evidence*** that the Fisher '266 patent was not enabled at any time before the district court's Order. As the party seeking a preliminary injunction, that lack of evidence was fatal to Halliburton's burden to show that

Defendants' challenges to the validity of the patents-in-suit "lack[ed] substantial merit." *Purdue Pharma L.P. v. Boehringer Ingelheim GmbH*, 237 F.3d 1359, 1366 (Fed. Cir. 2001). While Halliburton now argues that it showed its model to the district court without objection (Blue Br. 35), Halliburton offered neither the model itself nor any evidence about its construction or relationship to the Fisher disclosure at any time during the hearing. Of course, attorney argument is not evidence. Moreover, even if the model was considered, the district court implicitly found Halliburton's arguments about Fisher's alleged leaks unpersuasive.

On reconsideration, Halliburton belatedly argued that Fisher was non-enabling because the disclosed "sealing means" of the packing ring 22 did not actually seal. As already explained, the district court rejected Halliburton's attempted reliance on *Amgen* as grounds for reconsideration, and denied Halliburton's attempt to introduce its belated evidence to satisfy the burden of proof that it had all along.[3] A24; *see Amazon.com*, 239 F.3d at 1350-51. As *Amgen* confirms, therefore, the Fisher patent is presumptively enabled and

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[3] As Weatherford explained to the district court, *Amgen* did not change the law, but reflected existing precedent that claimed and unclaimed disclosures in a prior art patent are presumptively enabled. *See* 314 F.3d at 1355. Weatherford also explained that *Amgen* was inapposite to this case because the "sealing engagement" element that Halliburton argued was not enabled was ***claimed*** in claims 2, 3, and 6 of the Fisher '266 patent. *See* A1206 (claiming "elastic means surrounding said segments adapted to be caused to engage the casing . . . to form a tight seal therewith").

Halliburton has no grounds by which to overcome that presumption. *See* 314 F.3d at 1355. Now, with no supporting evidence of record, Halliburton can only repeatedly insist before this Court that Fisher "inherently" leaks. *See, e.g.*, Blue Br. 34, 54-57. Of course, such unsupported attorney argument should fare no better here than it did in the district court.

Before denying Halliburton's motion for reconsideration, the district court invited Defendants to submit evidence responding to Halliburton's evidence concerning Fisher's wooden bridge plug. A1932. Weatherford submitted evidence, including two declarations identifying material differences between Halliburton's "model" and the Fisher specification (particularly in the seal dimensions) and describing Weatherford's own test results showing that a downhole tool made in conformance with the Fisher patent would effectively seal a wellbore casing. Subsequently, the district court denied Halliburton's motion for reconsideration without considering either party's additional evidence. A25 n.2. Because Halliburton now concedes that its reconsideration attempt was properly denied, there is still no evidence that Fisher's bridge plug would not seal.

For purposes of its preliminary injunction motion, Halliburton thus completely failed to meet its burden of proving that the Fisher downhole plug was not enabled. Moreover, Weatherford clearly showed that the Fisher patent discloses every element of claims 1 and 30 of the '468 patent and claim 3 of the

'540 patent. Consequently, the district court correctly concluded that the Fisher patent presents substantial questions concerning the validity of each of the asserted claims.

2. The Baker Fiberglass Packers Also Invalidate The Asserted Claims

Other prior art, particularly the Baker fiberglass packers, raised equally substantial validity questions. The district court correctly found that in view of the Baker packers, claim 30 of the '468 patent and claims 1 and 2 of the '540 patent were anticipated or obvious, and that claim 1 of the '468 patent and claim 3 of the '540 patent were obvious over the Baker packers in combination with other art. A16-17.

a. The Baker Packers Anticipate Claim 30 of the '468 Patent

Advertisements from 1968 (A842, A848) and pages of Baker's Special Products Manual describing the Baker fiberglass packers (A843-44) show that the packers included a nonmetallic center mandrel, packing means for sealing the wellbore, and a slip assembly including slips, an integral slip support, and a slip wedge, all made of non-metallic materials. When either of these fiberglass packers was set in a wellbore, the slips "grippingly" engaged the wellbore to lock the packer in place until its release mechanism was manipulated. A1071(15:16-18) (noting that the Baker fiberglass packers had an emergency release system to

disengage the packers from the wellbore; the release would "de-energize everything and separate the cone from the slip.").

Although Halliburton argued that the Baker fiberglass packers are not relevant prior art because they were designed to be retrievable (A901), claim 30 of the '468 patent requires neither a step of drilling out the packer nor the "locking engagement" that Halliburton contends excludes retrievable tools. In any case, the evidence of record indisputably shows that Baker developed, advertised and sold at least two types of fiberglass packers in the 1960s: a part fiberglass/part metal packer that included a fiberglass mandrel, as well as an all-fiberglass packer. A1191; A842, A848. Because these tools included every limitation of claim 30, the district court was correct to conclude that claim 30 was likely anticipated by, and thus invalid over, the Baker packers.

b. The Baker Packers Render Claim 1 Of The '468 Patent and Claim 3 of the '540 Patent Obvious

The district court also properly concluded that the Baker packers, in combination with other art, were likely to render claim 1 of the '468 patent obvious. The district court found, and Halliburton does not dispute, that one of the Baker packers included a nonmetallic center mandrel and a plurality of slips arranged around the mandrel. A16. The district court also correctly found that the Baker packers could be set in "locking, sealing engagement" with the wellbore. *Id.*

Once set, the Baker fiberglass packer "lockingly" engaged the wellbore and would not move up or down within it, as the slips were designed to grip the wellbore and prevent movement of the packer within the casing. A1192(¶8). Similarly, the packing elements of the Baker fiberglass packer "sealingly engaged" the wellbore when it was set downhole. The packing elements were disposed on the mandrels of the fiberglass packers, and they were specifically designed to seal with the wellbore and prevent fluid from leaking through the annular area between the packer and the casing. *See id.*

Although the district court found that the Baker fiberglass packers were not designed to be "drilled out" of a wellbore as required by claim 1 of the '468 patent, A16-17, the district court nevertheless concluded that the prior art plainly disclosed the benefits of drillable bridge plugs and that non-metallic components improve drillability. A17.[4] Thus, the district court implicitly found that the Fisher '266 patent and the Sukup '202 patent (A1606-21) provided a motivation to use non-metallic packers, such as the Baker fiberglass packers, in applications requiring drill-out rather than retrieval. A17. Accordingly, the district court correctly

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4 The evidence also showed that "retrievable" packers such as the Baker fiberglass packers often had to be drilled out of a casing. A1192(¶9). Indeed, Halliburton's own 1962 sales catalog confirms that its R-3 retrievable Treating-Production Packer was designed to be drillable. A1198 ("Drillability—Contains safety joint to allow tubing to be removed and *packer easily drilled* if conditions prevent normal removal").

concluded that the method of claim 1 of the '468 patent would have been obvious over the Baker fiberglass packers.

Using a similar analysis, the district court also properly concluded that claim 3 of the '540 patent would have been obvious over the Baker fiberglass packers in combination with the dual-slip configuration of either the Fisher '266 patent or the Muse '366 patent (A864-75). A19. Halliburton's argument (Blue Br. 11, 62) that the Sukup '202 patent teaches away from a dual-slip configuration is unavailing. Contrary to Halliburton's assertions, the Sukup patent never states that the dual-slip design is "unworkable"; the patent actually states that configuration is "generally acceptable" although not the "most efficient arrangement." A1612(2:19-22). A clear statement that a dual-slip design is acceptable is hardly the unambiguous discouragement required for "teaching away." *See, e.g., In re Gurley*, 27 F.3d 551, 552 (Fed. Cir. 1994) (a reference teaches away only if "a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant").

Furthermore, Halliburton completely ignores that the slip assembly disclosed in the Sukup '202 patent includes two "slip wedges" (designated 96 and 180 in Figure 7), two "slip supports" (300, 34), and "slips" (362) with oppositely directed, separately engageable upper and lower teeth (designated 380, 382 in Figure 1) such

that when the tool is set, the slip assembly performs the identical function in substantially the same way as Halliburton's dual-slip configuration. Not surprisingly, that configuration allowed the composite downhole tool disclosed in the Sukup patent to be positioned into "locking, sealing engagement" with a wellbore.

Moreover, as the district court further recognized, the prior art in this crowded field contained numerous examples of drillable tools with dual-slip designs other than the Sukup patent, including the Fisher patent, the Muse '366 patent, and Halliburton's U.S. Patent No. 4,151,875 to Sullaway (A1591-1600). In view of such references, Halliburton failed to show that the prior art as a whole taught away from the asserted claims, much less that Weatherford's obviousness defenses lacked substantial merit.

In the face of Weatherford's strong showing, Halliburton merely complains that the district court improperly assessed obviousness before considering the objective or "secondary" factors, and thus erred by concluding they were insufficient to overcome the evidence of obviousness. Blue Br. 58-59. However, the district court clearly considered all the relevant evidence. A6 (listing the four factors under *Graham v. John Deere Co.*, 383 U.S. 1 (1966), including secondary considerations). Moreover, the district court did not err in assessing *prima facie* obviousness before considering the objective factors. *See, e.g., Sandt Tech., Ltd. v.*

Resco Metal & Plastics Corp., 264 F.3d 1344, 1355 (Fed. Cir. 2001) ("Sandt also argues that the district court erred in failing to weigh secondary considerations. ... The district court, however, did review Sandt's evidence of commercial success, and properly found that it did not alter its conclusion that claims 3 and 19 of the '057 patent were invalid as obvious.").[5]

The district court could not have abused its discretion by analyzing the evidence of obviousness in a manner approved by this Court's precedent. Moreover, the district court clearly gave Halliburton the benefit of the doubt as to all the secondary considerations, even though not all were supported by the evidence. *See National Steel Car*, slip op. at 35-36 (holding that a district court abused its discretion in relying on a failure of others and a long-felt need in the industry where the evidence showed the real reason was simply a lack of customer interest). When this Court examines the secondary considerations listed by the district court, it will find no evidence showing a nexus between Halliburton's alleged commercial success and its claimed inventions. *See, e.g.*, *Sjolund v. Musland*, 847 F.2d 1573, 1582 (Fed. Cir. 1980) (commercial success is relevant only if it flows from the merits of the claimed invention). Moreover, the

[5] *See also Ecolochem v. So. Cal. Edison Co.*, 227 F.3d 1361, 1375 (Fed. Cir. 2000) (considering whether secondary considerations rebutted *prima facie* case of obviousness); *Newell Cos. v. Kenney Mfg. Co.*, 864 F.2d 757, 768 (Fed. Cir. 1988) (secondary factors must be considered but do not control obviousness determination).

"evidence" of copying is merely Halliburton's assertions that any downhole composite tool infringes and that all such alleged infringement must have resulted from copying. A919-20. Thus, given that the district court accorded more weight to the secondary considerations than they deserved, the district court did not abuse its discretion in finding substantial questions of obviousness exist in this case.

D. Halliburton's Requested Relief Is Improper

According to Halliburton, if this Court adopts Halliburton's proposed claim construction, then the Court should direct the district court to enter a preliminary injunction on remand. Blue Br. 65. But even if this Court reviews and disagrees with some aspect of the district court's preliminary claim construction, or even if it were to accept Halliburton's proposed construction, Halliburton's requested relief is clearly inappropriate.

As explained above, the district court concluded that Weatherford had raised multiple substantial challenges to the validity of each asserted claim. Once the district court reached that conclusion, it had no reason to address any of the other relevant preliminary injunction factors. *See Jack Guttman, Inc. v. Kopykake Enters., Inc.*, 302 F.3d 1352, 1356 (Fed. Cir. 2002) (a trial court may "deny a [preliminary injunction] motion based on a patentee's failure to show any one of the four factors").

Granting a preliminary injunction, however, "requires analysis of all four factors." *Id.* As this Court has repeatedly instructed, "[t]he balancing of the four factors, of course, rests within the discretion of the trial court, not the appellate court." *Id.* at 1363.[6] Nevertheless, Halliburton wants this Court to analyze the factors not reached by the district court, resolve and balance them in favor of Halliburton, and direct entry of an injunction. Even ignoring Halliburton's erroneous contention that it made a strong showing of likely success on validity (*see supra* section V.B), this Court in *Guttman* squarely rejected the propriety of Halliburton's requested remedy.

In *Guttman*, the patentee convinced this Court that the claim construction used by the district court in denying a preliminary injunction was incorrect. On that basis, the patentee urged this Court to reverse and remand with instructions to enter a preliminary injunction. 302 F.3d at 1362. The Court explained that such a course of action would be inappropriate for several reasons. *Id.* Those same reasons would apply equally here.

First, this Court in *Guttman* recognized that the trial court had not yet determined whether, under the proper claim construction, the patentee was likely to

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[6] *See also Black & Decker, Inc. v. Hoover Service Ctr.*, 886 F.2d 1285, 1296 (Fed. Cir. 1989) (finding that district court erred in analyzing likelihood of success on infringement but remanding for determinations "yet to be made, and properly only to be made in the first instance, by the district court"); *Fromson*, 853 F.2d at 1570 (noting that the Federal Circuit "will not find the facts *de novo*."

show infringement, an issue involving factual determinations within the district court's province, not the appellate court's. 302 F.3d at 1362. Moreover, because the defendant in *Guttman* urged affirmance on an alternative limitation that the district court had not yet construed, this Court recognized that the parties would need to revisit on remand whether that unresolved issue would determine the infringement inquiry. *Id.* at 1362 n.1.

Similarly, Weatherford would be entitled on remand to demonstrate why the asserted claims would still likely be invalid or not infringed under any modified preliminary construction adopted by this Court. Moreover, other limitations have yet to be construed or applied to the accused devices by the district court. Since the briefing of this motion, Weatherford has also developed additional defenses that the district court would then need to consider before determining the propriety of any preliminary injunctive relief.

Finally, in addition to its strong showing of likely invalidity, Weatherford made a strong showing that the other relevant factors weighed against entry of a preliminary injunction. Like Halliburton here, Guttman tried to sidestep that showing on appeal by relying on a presumption of irreparable harm, but this Court explained that such presumption arises only where there is a clear likelihood of success, which had yet to be evaluated under this Court's revised claim construction. 302 F.3d at 1363. Moreover, this Court stressed that such

presumption, even if it arose, was rebuttable, and that a defendant must be afforded the opportunity to rebut it. *Id.*

This Court in *Guttman* explained that no one factor is determinative and that the district court must evaluate all four factors and balance them against each other to determine whether a preliminary injunction would be appropriate. *Id.* Because any required reevaluation of the relevant factors rests within the discretion of the district court, not the appellate court, this Court held that the appropriate remedy is not to reverse with instructions to enter the injunction, but to vacate the appealed order denying injunctive relief and remand for further proceedings in light of the appellate opinion. *Id.*; *see also Polymer Techs., Inc. v. Bridwell*, 103 F.3d 970, 977 (Fed. Cir. 1996) (vacating denial of preliminary injunction where the district court erroneously held the presumption of irreparable harm was rebutted, but declining to make findings on the other factors not addressed by the district court).

In light of *Guttman*, it should almost never be appropriate for this Court to direct the entry of a preliminary injunction after reversing the denial of such an injunction. By requesting that remedy based on the limited record that existed when the present motion was briefed, Halliburton is attempting to turn the clock back to at least September 2002 and to force the district court to ignore all subsequent discovery and intervening developments. Indeed, if this Court instructs the district court to do anything on remand, it should be directed to forgo any

further preliminary injunction proceedings in light of the substantial validity questions Defendants have already raised and to advance the case toward a complete *Markman* hearing on a full record so that this case can be resolved on the merits, either through summary judgment or trial.

E. The Remaining Preliminary Injunction Factors Strongly Support The District Court's Ruling

Even if this Court accepts Halliburton's invitation to analyze for the first time on appeal the preliminary injunction factors not addressed by the district court, the denial of Halliburton's motion still should be affirmed. Contrary to Halliburton's suggestions that there are no material facts in dispute (Blue Br. 44) and that the district court's failure to address the other factors means that they can be resolved in favor of Halliburton (Blue Br. 65), the record demonstrates conclusively that Halliburton failed to establish any of the factors necessary for preliminary injunctive relief.

1. The District Court Never Addressed Halliburton's Likelihood Of Success On Infringement

Given the logistical constraints and evidentiary limitations created by a preliminary injunction motion filed with the complaint, Weatherford concluded (correctly) that demonstrating the likely invalidity of the asserted claims would suffice to defeat Halliburton's requested injunctive relief. No precedent required Weatherford to present a substantial question as to ***both*** invalidity and non-

infringement. In contrast, the patentee is required to establish a likelihood of success on both issues. *See Nutrition 21 v. United States*, 930 F.2d 867, 871 & n.3 (Fed. Cir. 1991). As in *Nutrition 21*, nothing was said here about infringement, which means the district court never decided whether Halliburton had a likelihood of success on that issue.

Even on an unopposed motion, the court must still satisfy itself that the movant is entitled to the requested relief. *See, e.g., Univ. of W. Va. Bd. of Trustees v. VanVoorhies*, 84 F. Supp. 2d 759, 771 n.90 (D. W.Va. 2001) (summary judgment), *aff'd*, 278 F.3d 1288 (Fed. Cir. 2002). Moreover, unlike the presumption of validity, which permits the court to assume a likelihood of success on validity where there is no opposition, there is no presumption of infringement. Given that it is a patentee's burden, and that the district court did not discuss the adequacy of Halliburton's showing, Halliburton's likelihood of success on infringement remains unresolved on this record and will be contested by Weatherford on any remand.

2. Halliburton Is Not Entitled To A Presumption Of Irreparable Harm

The absence of irreparable harm provides a proper basis to deny a preliminary injunction without regard to the other factors. *See Polymer Techs.*, 103 F.3d at 974 (observing that the district court did not err in focusing its analysis

solely on irreparable harm). Relying solely on a presumption to which it is not entitled, Halliburton cannot possibly show irreparable harm on this record.

For the reasons already stated, Halliburton failed to show ***any*** likelihood of success on the merits, much less the "clear showing" of validity that is required for the presumption of irreparable harm even to arise. *See Purdue Pharma*, 237 F.3d at 1363. This Court should recognize that there are substantial invalidity questions in light of the prior art, regardless of whether it accepts Halliburton's proposed claim construction. Nevertheless, even assuming Halliburton had a sufficiently strong showing on the merits to warrant a presumption of irreparable harm (which it did not), the existing record refutes any notion that Halliburton would be irreparably harmed in the absence of preliminary injunctive relief.

a. Halliburton's Only Evidence Does Not Demonstrate Irreparable Harm

In the district court, Halliburton offered only the bald assertion that damages would be inadequate based on loss of market share. A1237-38. However, neither the difficulty in calculating market share losses nor speculation that such losses might occur, "amount to proof of special circumstances justifying the extraordinary relief of an injunction prior to trial." *See, e.g.*, *Nutrition 21*, 930 F.2d at 871 (noting that reliance on possible market share loss would apply in every patent case where the patentee practices the claimed invention).

Likewise, Halliburton's attempts (Blue Br. 67) to rely on the "finite" patent term and on the time needed to obtain a final decision in litigation would require a conclusion of irreparable harm in every patent case. This Court has rejected similar assertions and should do so again here. *See, e.g., Reebok Int'l Ltd. v. J. Baker, Inc.*, 32 F.3d 1552, 1558-59 (Fed. Cir. 1994) (if loss of the right to exclude during litigation established irreparable harm, no patentee could be denied injunctive relief); *Illinois Tool Works, Inc. v. Grip-Pak Inc.*, 906 F.2d 679, 683 (Fed. Cir. 1990) (the assumption that an infringer's sales during litigation will always irreparably harm the patentee would disserve the patent system and require such a finding for every patentee, regardless of circumstances).

Halliburton also ignores Weatherford's evidence directly refuting Halliburton's contention that Weatherford was unfairly gaining market position by undercutting Halliburton's price. A852-53(¶¶9-10). The record demonstrates that Weatherford's sales have resulted from the quality and functionality of its composite tools and from frustration by Halliburton's customers with Halliburton's heavy-handed marketing techniques (including tying its sales of composite tools to other services). A850-51(¶¶7-8). Hence, Halliburton's conclusory arguments regarding its alleged irreparable harm (Blue Br. 66-67) are neither uncontroverted nor compelling.

Finally, Halliburton has not alleged that Weatherford could not satisfy whatever monetary judgment might be awarded. Moreover, Halliburton's only proffered "evidence" of irreparable harm confirms that monetary damages would be sufficient in this case. A921. Halliburton's Ortiz declaration identified specific wells in specific locations that needed specific numbers of bridge plugs. A5002-05. Mr. Ortiz not only provided detailed information about Halliburton's and Weatherford's pricing for these plugs, he estimated the monetary value of Halliburton's anticipated lost sales. A5002-03. Far from suggesting any irreparable harm, this estimate represents affirmative proof that monetary relief will adequately compensate Halliburton for any adjudicated infringement. A5018-19 n.3.

b. Halliburton's Dilatory Conduct And Acquiescence To Others' Infringement Refute Any Irreparable Harm

Halliburton's delay in filing this lawsuit and its actions creating additional unnecessary delay during the litigation are wholly inconsistent with its allegation of irreparable harm. *See T.J. Smith & Nephew Ltd. v. Consol. Med. Equip., Inc.*, 821 F.2d 646, 648 (Fed. Cir. 1987) (delay is a key factor tending to show absence of irreparable injury). As outlined, Halliburton filed suit (A100) over ten months after sending its cease-and-desist letter regarding Weatherford's tools (A826) and five months after conducting a hands-on inspection of Weatherford's composite

bridge plug. A830-32. Such periods of delay before bringing suit strongly rebut any presumption of irreparable harm.[7]

Perhaps more significantly, Halliburton's largest competitor, Baker Hughes, began manufacturing and selling composite downhole tools four to five years before Halliburton filed this action against Weatherford and BJ. A832(¶¶14-15). Baker's composite tools have the same features that Halliburton alleges infringe its patents-in-suit, yet Halliburton is allowing Baker to compete unimpeded with Halliburton. A832(¶¶14-15). *See Polymer Techs.*, 103 F.3d at 976 (failure to sue other infringers may be relevant to irreparable harm "when it indicates unreasonable delay in bringing suit ... or indifference in enforcing one's patent").

While Halliburton unsuccessfully tried to suggest in the district court that Baker had been selling competing composite tools for only two years before Halliburton sued Defendants (A1239), Halliburton's failure to challenge Baker's

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[7] *See, e.g.*, *Nutrition 21*, 930 F.2d at 872 ("that Nutrition 21 delayed a substantial period of time before seeking a preliminary injunction at least suggests that the status quo does not irreparably damage Nutrition 21"), *aff'g* 14 USPQ2d 1244, 1246 (W.D. Wash. 1990) (noting that delay was only seven months); *Ethicon, Inc. v. U.S. Surgical Corp.*, 762 F. Supp. 480, 505 (D. Conn. 1991), *aff'd*, 965 F.2d 1065 (Fed. Cir. 1992) (presumption, even if warranted, was substantially rebutted by plaintiff's one-year delay in seeking an injunction), *aff'd*, 965 F.2d 1065 (Fed. Cir. 1992); *T.J. Smith & Nephew*, 821 F.2d at 648 (15-month delay in seeking a preliminary injunction is incompatible with emphasis on right to exclude that is basis for presumption of irreparable harm); *American Permahedge, Inc. v. Baracana, Inc.*, 857 F. Supp. 308, 324 (S.D.N.Y. 1994) (failure to seek preliminary relief for over a year "undercuts the sense of urgency ... and suggests that there is, in fact, no irreparable injury").

activities would be unreasonable delay whether it was two, four, or more years, particularly since such acquiescence continues. Halliburton's indifference to Baker's ongoing sales of allegedly infringing composite tools fatally undermines Halliburton's claim that it would be irreparably harmed unless Defendants are preliminarily enjoined.

Finally, Halliburton's general counsel also submitted a declaration indicating that Halliburton and Baker had agreed to submit their patent disputes to confidential ADR procedures. A1697-98. However, the record contains no evidence that Halliburton has taken any steps to prosecute that proceeding in a manner consistent with its claim of irreparable harm in this action. Indeed, there is no evidence that the same patents are even at issue. More significantly, Halliburton's "evidence" suggests that it cannot exclude its biggest competitor. Because Halliburton's actions are incompatible with the statutory right to exclude, they indicate an absence of irreparable harm. *See Wang Labs., Inc. v. Mitsubishi Elecs. Am. Inc.*, 29 USPQ2d 1481, 1500 (C.D. Cal. 1993) (citing *T.J. Smith & Nephew*, 821 F.2d at 648). Thus, the evidence before the district court demonstrates that Halliburton failed to show any irreparable harm that could justify a preliminary injunction.

3. The Balance Of Hardships And The Public Interest Factors Also Favor Weatherford

Finally, Weatherford presented evidence to the district court demonstrating that the remaining two factors—the balance of hardships and the public interest—also favored denying Halliburton's request for preliminary injunctive relief. As to the former, Weatherford identified significant hardships it would suffer from a preliminary injunction. *See, e.g.*, A819-22; A855-56(¶¶17-18). Halliburton's only assertion on appeal is not based on any evidence, but only on the conclusory statement that "hardship to an infringer" cannot insulate it from being enjoined if the other three factors tip the scales in the patentee's favor. Blue Br. 67. As shown herein, however, the other factors all tip well in Defendants' favor, not Halliburton's.

In light of the substantial questions of validity, the resulting injury to Weatherford if the injunction is erroneously entered far outweighs any temporary injury to Halliburton from requiring it to compete in the marketplace until it establishes infringement liability on a full record. *See H.H. Robertson Co. v. United Steel Deck, Inc.*, 820 F.2d 384, 390 (Fed. Cir. 1987) (noting that "a preliminary injunction improvidently granted may impart undeserved value to an unworthy patent"). Here, Halliburton's unsupported and pejorative labeling of Defendants as "infringers" and "copiers" has already been shown to be unlikely to

be proven on the merits, so there is no reason to alter the *status quo* at this point in the litigation.

Weatherford similarly detailed the substantial adverse effect that a preliminary injunction would have on innocent third parties and the public interest. *See* A862-63(¶¶5-7). Halliburton responds only by citing the "strong policy in enforcing patent rights." Blue Br. 68. However, in *Novo Nordisk v. Genentech, Inc.*, 77 F.3d 1364, 1371 (Fed. Cir. 1996), this Court observed that "[n]either the public interest nor equity favors grant of an injunction against one who does not infringe." Similarly, there is no legitimate public policy or equity served by granting equitable relief on the basis of patent claims of highly dubious validity. *See Illinois Tool Works*, 906 F.2d at 684 (public interest in protecting patent rights counterbalanced by defendant's continuing right to compete, which is legitimate at the preliminary motion stage in light of "remote" showing of likelihood of success). Hence, as no relevant factor favors Halliburton, the district court's Order should be affirmed.

VI. CONCLUSION

For the reasons set forth above, the district court's order denying Halliburton's motion for a preliminary injunction should be affirmed.

Dated: 2-10-2004

Respectfully submitted,

HOWREY SIMON ARNOLD & WHITE, LLP

By: Richard L. Stanley

Counsel for Defendant-Appellee
Weatherford International, Inc.

CERTIFICATE OF COMPLIANCE

Pursuant to Fed. R. App. P. 37(a)(7)(C), the undersigned hereby certifies that the foregoing **BRIEF OF DEFENDANT-APPELLEE WEATHERFORD INTERNATIONAL, INC.** was generated using Microsoft Word 2000, which software reports that the portions of the brief not excluded by Fed. R. App. P. 37(a)(7)(iii) and Fed. Cir. R. 32(b), contain 13,754 words.

CERTIFICATE OF SERVICE

I certify that the original and twelve copies of this BRIEF OF DEFENDANT-APPELLEE WEATHERFORD INTERNATIONAL, INC. have been shipped today via Federal Express, next day delivery, to the Clerk's Office, U.S. Court of Appeals for the Federal Circuit, 717 Madison Place, N.W., Washington, DC 20439.

I also certify that two true and correct copies of the BRIEF OF DEFENDANT-APPELLEE WEATHERFORD INTERNATIONAL, INC. were served via Federal Express, next day delivery, to each of the following counsel:

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Dated: February 10, 2004

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Exhibit

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ORIGINAL

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

HALLIBURTON ENERGY SERVICES, INC.	§	
Plaintiff,	§	
v.	§	Civil Action No. 3:02-CV-1347-N
WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY	§	
Defendants,	§	

MEMORANDUM OPINION AND ORDER

Plaintiff Halliburton Energy Services, Inc. ("Halliburton") complains against Defendant Weatherford International, Inc. ("Weatherford") and Defendant BJ Services Company ("BJ") for patent infringement under 35 U.S.C. §§ 1, *et seq*. Halliburton seeks judgment against the Defendants and injunctive relief against further infringement of the claims of United States Patent Number 5,271,468 (the " '468 patent"), issued December 21, 1993 and United States Patent Number 5,224,540 (the " '540 patent"), issued July 6, 1993, each entitled "Downhole Tool Apparatus with Non-Metallic Components and Methods of Drilling Thereof."

Before the Court is Halliburton's motion for a preliminary injunction. Oral arguments were held on Halliburton's motion on September 19, 2002. After considering the Parties' briefs and arguments, and for the reasons stated below, this motion is DENIED.

I. Background

Halliburton, Weatherford, and BJ all provide services and equipment to customers in the oil industry. Halliburton's patents at issue in this action relate to oil well tools called bridge plugs, see Figure 1 from the '468 patent at right. Bridge plugs are used to seal off or "plug" portions of an oil well during certain oil production procedures. Often times after the procedures are complete, bridge plugs are removed from the oil wells. The claims at issue for the purpose of deciding this motion pertain to the bridge plug apparatus itself and a method of setting the bridge plug in a well bore[1] and then removing the plug by drilling it out. Figure 1 illustrates a bridge plug set in place in a well casing about to be drilled out and removed from the well.

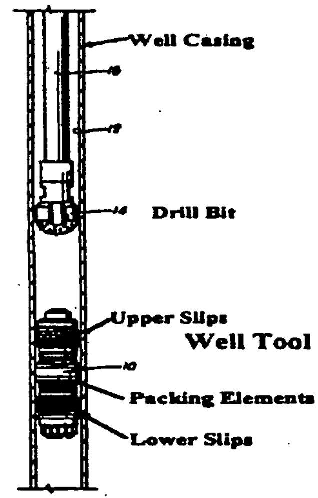

FIG. 1

5,271,468

Traditionally, bride plugs were constructed of metals such as steel or cast-iron. The relevant claims of Halliburton's '468 and '540 patents pertain to bridge plugs made of non-metallic component parts. The relevant component parts of a bridge plug include (1) a center mandrel – the main structural body on which the tool is built, (2) a packing element – an

[1]A well bore is a hole made by a drilling rig. Oil and gas wells are drilled into the earth using large drilling rigs capable of lifting and rotating long, heavy strings of drill pipe with a drill bit at the end. These wells can be very deep, penetrating thousands of feet into the earth. After the well is drilled, a string of relatively large-diameter tubing called casing is lowered into the well bore by the drilling rig and then cemented into place. For the purposes of this opinion, the well bore and the well casing are treated as the same structures.

often doughnut-shaped, rubber element positioned around the center mandrel to seal off the lower portion of the well bore, and (3) slips – anchoring assemblies to hold the tool in place. Figure 8 from the '468 patent, depicted on the right, demonstrates one embodiment of Halliburton's bridging plug. The anchoring components in figure 8 consist of upper and lower slips, slip supports, and wedges. When the well tool is set, the packer elements are compressed and expand to form a seal with the well casing (as shown). This expansion pushes the upper wedge upward and the lower wedge downward and the forces the slips outward to engage the well casing. In this embodiment of the Halliburton's invention, the slip supports help hold the slips, and therefore the bridge plug, in place in the well bore. Halliburton claims that its tool's non-metallic composition allows for a less expensive and more reliable removal of the plug from an oil well bore.

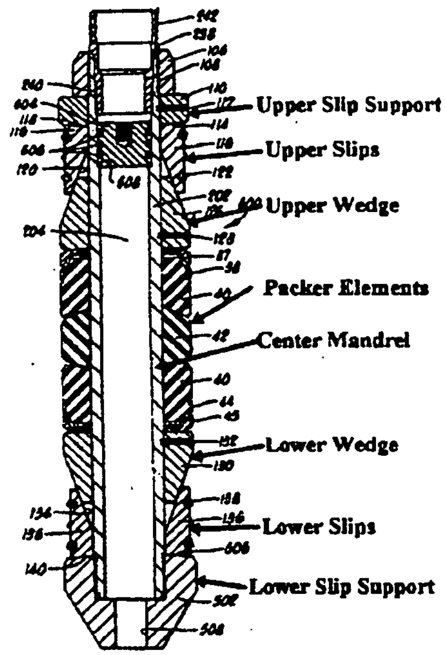

FIG. 8

5,271,468

Halliburton's non-metallic bridge plugs, marketed as part of their FAS DRILL® tool line, are removed by drilling the plugs out of the well bore. The plugs are drilled into small bits and chips that can be circulated through and flushed out of the well bore. Halliburton asserts that prior to its non-metallic tools, most drillable bridge plugs were constructed of cast-iron. These cast-iron plugs were more costly and problematic to drill out of well bores

than non-metallic plugs. Halliburton claims that its FAS DRILL® plugs can be removed from well bores with less expensive equipment, in less time, and with fewer problems than their metallic counterparts.

Halliburton contends in its motion that Weatherford and BJ are infringing upon claims 1 and 30 of its '468 patent and claim 3, which is dependent upon claim 2, which is dependent upon claim 1, of its '504 patent. These claims read as follows:

Claim 1 of the '468 Patent

1. A well bore process comprising the steps of:
constructing a downhole tool such that a component thereof is made of a non-metallic material, said tool comprising:
a center mandrel; and
a plurality of slips disposed around said mandrel for grippingly engaging a well bore when in a set position;
wherein at least one of said mandrel and said plurality of slips is said component;
positioning said downhole tool into locking, sealing engagement with said well bore; and
drilling said tool out of said well bore.

Claim 30 of the '468 Patent

30. A downhole apparatus for use in a well bore, said apparatus comprising:
a center mandrel made of non-metallic material; and
slip means disposed on said mandrel for grippingly engaging said well bore when in set position.

Claims 1-3 of the '540 Patent

1. A downhole apparatus for use in a well bore, said apparatus comprising:
a center mandrel; and
slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means being at least partially made of a non-metallic material.

2. The apparatus of claim 1 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

3. The apparatus of claim 2 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means being at least partially made of a non-metallic material.

Halliburton argues that Weatherford's FracGuard Composite plugs and BJ's Python Composite plug incorporate aspects of its FAS DRILL® tools and infringe upon the cited patent claims. The Defendants' plugs, Halliburton asserts, have non-metallic center mandrels and slip assemblies made at least partially of non-metallic materials. Additionally, Halliburton claims that the Defendants' marketing materials boast quick and easy drill outs of their composite (non-metallic) plugs.

II. Discussion

To obtain a preliminary injunction, Halliburton must show "(1) a reasonable likelihood of success on the merits; (2) irreparable harm if an injunction is not granted; (3) a balance of hardships tipping in its favor; and (4) the injunction's favorable impact on the public interest." *Amazon.com, Inc. v. Barnesandnoble.com, Inc.*, 239 F.3d 1343, 1350 (Fed. Cir. 2001). With regard to the first element, Halliburton must show, in light of the burdens that will inhere at trial, that (1) its patent was infringed, and (2) any challenges to the validity and enforceability of its patent "lack substantial merit." *Purdue Pharma L.P. v. Boehringer Ingelheim GmbH*, 237 F.3d 1359, 1366 (Fed. Cir. 2001).

Weatherford and BJ challenge the validity of Halliburton's patents. Specifically, the Defendants claim that Halliburton's relevant patent claims were anticipated or rendered obvious by prior art. An assessment of the likelihood of validity of a patent claim over the prior art also involves a two-step process. First, the court determines the scope and meaning of the patent claims asserted to determine the subject matter for which patent protection is sought. *See Smiths Indus. Med. Sys., Inc. v. Vital Signs, Inc.*, 183 F.3d 1347, 1353 (Fed. Cir. 1999). Secondly, the properly construed claims are compared with the prior art. *Id.* at 1354. A determination that a claim is invalid as being anticipated or lacking novelty under 35 U.S.C. § 102 requires a finding that "each and every limitation is found either expressly or inherently in a single prior art reference." *Celeritas Techs. Inc. v. Rockwell Int'l Corp.*, 150 F.3d 1354, 1361 (Fed. Cir. 1998). Whether a claim would have been obvious within the meaning of 35 U.S.C. § 103 is a question of law based on underlying findings of fact including: "(1) the scope and content of the prior art, (2) the level of ordinary skill in the art, (3) the differences between the claimed invention and the prior art, and (4) secondary considerations of nonobviousness." *Smiths*, 183 F.3d at 1354 (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)).

Because an issued patent is presumed to be valid, 35 U.S.C. § 282, the Defendants must establish invalidity by clear and convincing evidence. *WMS Gaming Inc. v. Int'l Game Techs.*, 184 F.3d 1339, 1355 (Fed. Cir. 1999). In the context of a preliminary injunction, however, while "the burden of proving invalidity is with the party attacking validity," the party seeking the injunction "retains the burden of showing a reasonable likelihood that the

attack on its patent's validity would fail." *H.H. Robertson Co. v. United Steel Deck, Inc.*, 820 F.2d 384, 387 (Fed. Cir. 1987). When the presumptions and burdens applicable at trial are taken into account, the injunction should not issue if the party opposing the injunction raises "a substantial question concerning infringement or validity, meaning that it asserts a defense that [the party seeking the injunction] cannot prove lacks substantial merit." *Tate Access Floors v. Interface Architectural Resources, Inc.*, 279 F.3d 1357, 1365 (Fed. Cir. 2002) (internal quotation marks omitted); *New Eng. Braiding Co. v. A.W. Chesterton Co.*, 970 F.2d 878, 883 (Fed. Cir. 1992) ("While it is not the patentee's burden to prove validity, the patentee must show that the alleged infringer's defense lacks substantial merit.").

A. Anticipation by the '266 Patent

Both Defendants argue that Halliburton's patents are invalid because of anticipation. A patent is anticipated and therefore invalid when the invention was described in a printed publication either before the date of invention by the applicant or more than one year before the date of the application for the patent in the United States. 35 U.S.C. §§ 102(a), 102(b) (2003). For a claim to be invalid on the basis of anticipation under section 102(b), "[t]he invention must have been known to the art in the detail of the claim; that is, all of the elements and limitations of the claim must be shown in a single prior art reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001).

Weatherford argues in its surreply that United States Patent Number 1,684,266 (the " '266 patent"), entitled "Bridging Plug," issued on September 11, 1928 anticipates the

relevant claims of Halliburton's '468 and '540 patents. The '266 patent is for an improved bridge plug made of wood, a non-metallic material.[2] This patent raises a substantial question regarding the validity of Halliburton's relevant patent claims.

1. Claim 1 of the '468 Patent

Claim 1 of the '468 patent describes a process for (i) locking and (ii) sealing an oil well tool, i.e. bridge plug, in a well bore and then (iii) drilling the tool out of the hole. The '468 tool apparatus itself contains (iv) a center mandrel and (v) a plurality of slips (for positioning the tool in place) wherein (vi) either the mandrel or the slips are made of a non-metallic material. In comparison, the '266 patent discloses a bridging plug that has (iv) a center mandrel constructed of (vi) wood that can be easily (iii) drilled out of a well bore. App. at W00213, lines 16-21, 90-98. The '266 plug utilizes a (v) plurality of slips that (i) engage the well bore to prevent movement of the tool when the plug is set. App. at W000214, lines 3-12. The '266 bridging plug also has rubber rings distributed around the mandrel for (ii) sealingly engaging the well bore when the plug is locked in position. *Id.* at lines 68-73. The '266 patent, therefore, discloses the elements and limitations of Claim 1 of the '468 patent.

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[2]The Patent and Trademark Office ("PTO") did not review the '266 patent prior to its issuance of Halliburton's patents-in-suit. "Deference is due the PTO's decision to issue a patent with respect to evidence bearing on validity which it considered but no such deference is due with respect to evidence it did not consider." *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1359 (Fed. Cir.), *cert. denied*, 469 U.S. 821 (1984).

2. Claim 30 of the '468 Patent

The '266 patent likewise appears to anticipate Claim 30 of the '468 patent. Claim 30 describes the bridge plug apparatus as comprising (i) a non-metallic center mandrel and (ii) a slip means disposed on the mandrel for grippingly engaging the well bore when the tool is in a set position. As discussed above, the '266 patent discloses a bridging plug apparatus containing (i) a non-metallic (wood) center mandrel and a plurality of slips for locking, or grippingly engaging, the well bore when the tool is set. The apparatus of claim 30 however differs from claim 1 in that 30 requires the apparatus to contain a "slip means." Halliburton argues that "slip means," as defined in the specification of the patent-in suit, includes (a) slips, (b) a cone for wedging the slips, and (c) a support structure for the slips on the opposite side of the slips from the wedge. App. at 000010, col. 3, l. 26-28; App. at 000029, col. 29-34. The Defendants do not offer an alternate construction of slip means. In response to Halliburton's construction of "slip means," Weatherford argues that the '266 plug utilizes (a) slips and (b) a tapered, conical wooden component that wedges the slips into engagement with the well bore. Weatherford, however, does not directly address in its argument whether the '266 patent discloses the element of a slip support structure on the opposite side of the slips from the wedge.

A *Markman* hearing will ultimately determine the proper construction of the term "slip means," however, for the purposes of this motion, the "slip means" language is broad enough to apply to the slip structure disclosed in the '266 patent. When claims are drafted in "means plus function" form, the presumption is that 35 U.S.C. § 112 ¶ 6 applies. A "means plus

function" claim limitation is construed to cover the structure disclosed in the specification of the patent to perform the claimed function plus equivalents of that structure. *Caterpillar Inc. v. Deere & Co.*, 224 F.3d 1374, 1379 (Fed. Cir. 2000).

The means plus function limitation does not override, however, the section 112 requirement that the claims particularly point out and distinctly claim the subject matter of the invention. *In re Donaldson Co.*, 16 F.3d 1189, 1195 (Fed. Cir. 1994). A claim can not be limited by reading the specification into the claim:

> it is the language itself of the claims which must particularly point out and distinctly claim the subject matter which the applicant regards as his invention, without limitations imported from the specification, whether such language is couched in terms of means plus function or consists of a detailed recitation of the inventive matter. Limitations in the specification not included in the claim may not be relied upon to impart patentability to an otherwise unpatentable claim.

In re Lundberg, 244 F.2d 543, 548 (C.C.P.A. 1957).

Claim 30 of Halliburton's '468 patent requires a slip means disposed on the tool's mandrel for grippingly engaging the well bore when the tool is in a set position. The claims of the '266 patent disclose slips engageable upon the casing, designed to prevent upward and downward movement of the plug within the casing. Functionally, both slip structures engage the well bore or well casing to prevent movement of the plug when the tool is set. If the precise structure of the "slip means" was critical to establishing the novelty of Halliburton's invention, then it was incumbent upon Halliburton to particularly point out and distinctly claim that structure. Because Halliburton's patent claims do not include a support structure

for the slips on the opposite side of the slips from the wedge, the Court declines to read this limitation into claim 30 of the '468 patent in order to avoid the anticipation of the '468 patent by the '266 patent. A slip support on the opposite side of the slips from the wedge, therefore, is not a necessary element of "slip means." The '266 patent, thus, discloses the elements and limitations of claim 1 of the '468 patent.

3. Claims 1-3 of the '540 Patent

Claim 3 of the '540 patent, like claim 30 of the '468 patent, is an apparatus claim describing the bride plug. The elements of claim 3, which is dependent upon claim 2, which is dependent upon claim 1, include (i) a center mandrel, (ii) a packing means disposed on the mandrel for sealingly engaging the well bore when the tool is set, (iii) a partially non-metallic slip means, wherein the slip means consists of (a) an upper slip means disposed above the packing means, and (b) a lower slip means, being at least partially non-metallic, disposed below the packing means. The '266 patent discloses these elements and limitations and therefore anticipates claim 3 of the '540 patent.

As discussed previously, the bridging plug described in the '266 patent has a (i) center mandrel. The '266 tool also has (ii) a packing means – rubber rings and possibly wooden segments[3] disposed on the mandrel that sealingly engage the well bore when the tool is set. App. at W000214, lines 68-73 ("The rubber rings 22 also engage the casing and are compressed, thus forming a packer or seal to prevent the leakage of fluid between the

[3]The wooden segments of the '266 tool form a cylinder around the mandrel, and when the tool is set, the segments push on the slip cones to lock the slips in the well bore.

exterior surface of the segments 10 and the casing."). As discussed in construing the elements of claim 30, the '266 tool contains (iii) a slip means partially made of wood. Additionally, the slip means consists of (a) upper slips located above the rubber rings and (b) lower slips located below the rings. App. W000214, l. 3-12 ("These [upper] slips have upwardly directed teeth 18, which, when they engage the casing C, will prevent upward movement of the plug within the casing. Each of the segments 10 has a stationary slip 19 secured to its lower end, these slips being provided with downwardly directed teeth 20, which, when they engage the casing, will prevent downward movement of the plug.") The lower slip means also utilize the wooden conical element for wedging the slips, therefore the lower slip means are partially non-metallic. The '266 patent, therefore, discloses the elements and limitations of Claim 3 of the '540 patent, and claims 1 and 30 of the '468 patent.

4. Halliburton Has Not Shown that Weatherford's Anticipation Defense Lacks Substantial Merit

Weatherford has succeeded with its burden of raising a substantial question regarding the validity of the relevant claims of Halliburton's patents-in-suit. Halliburton, however, has failed to show that Weatherford's defense lacks substantial merit. In its response to Weatherford's surreply, Halliburton argues that the '266 tool (1) cannot seal the well bore, (2) does not have a plurality of slips disposed on the mandrel, and (3) has no seal member on the mandrel. The Plaintiff's arguments are unavailing.

First, the relevant claims of Halliburton's patents do not require that the bridging plug perfectly seal the well bore. Claim 1 of the '468 patent, rather, requires that the bridge plug is positioned into a locking, sealing engagement with the well bore, and claim 2 of the '540 patent requires a packing means disposed on said mandrel for sealingly engaging the well bore. The '266 tool does sealingly engage the well bore – the '266 plug has rubber rings that engage the well bore when compressed "thus forming a packer or seal to prevent the leakage of fluid between the exterior surface of the segments 10 and the casing." App. at W000214, lines 70-73.

Halliburton's attorney further argued at the preliminary injunction hearing that the '266 plug does not sealingly engage the well bore because the spaces between the tool's wooden segments[4] form leak paths. The proper inquiry for a claim to be invalid on the basis of anticipation requires that "all of the elements and limitations of the claim be shown in a single prior art reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001). The language of the '266 patent discloses a tool that sealingly engages the well casing or well bore, therefore Halliburton's argument that the '266 plug does not actually seal the well bore fails to rebut Weatherford's invalidity defense.

Next, Halliburton argues that the '266 bridging plug does not have a plurality of slips disposed on the mandrel, rather the slips are on the tool's segments. In this argument, Halliburton mischaracterizes its claims. Claim 1 of the '468 patent requires "a plurality of

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[4]See footnote 3 for a description of segments.

slips disposed *around* said mandrel." Dispose means "to place or set in a particular order" or "to arrange." *See* THE AMERICAN HERITAGE® DICTIONARY OF THE ENGLISH LANGUAGE (4th ed. 2000). The slips of the '266 tool are placed or arranged around the mandrel. Claim 30 of the '468 patent and claim 1 of the '540 patent require that the *slip means*, rather than the slips themselves, is disposed on the mandrel. This argument fails for the purpose of determining this motion because the term "disposed on" does not require that the slip means be physically attached to the mandrel. The slip means of the '266 plug is arranged on the mandrel. Halliburton's argument regarding the disposition of the '266 slips thus fails.

Lastly, Halliburton asserts that the '266 tool does not have a seal member on the mandrel. Halliburton's patent claims, however, require only that a "packing means" be disposed on the mandrel. The rubber rings of the '266 patent are arranged on the mandrel, therefore Halliburton's defense fails. Halliburton, thus, has not shown that Weatherford's defense of anticipation fails. Halliburton's motion for preliminary injunction is denied, because Weatherford raised a substantial question regarding the validity of the relevant claims of Halliburton's '468 and '540 patents.

B. Obviousness of the '468 and '540 Patents

The Defendants also argue that prior art renders the relevant claims of Halliburton's patents-in-suit obvious. A patent claim will be invalid if it is obvious to one of ordinary skill in the pertinent art:

> [a] patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at

> the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. §103(a) (2003). The determination of obviousness can be made by comparing the claimed device to a single prior art reference. However, the obviousness determination is often made by comparing the claimed device to a combination of references. *Karsten Mfg. Corp.*, 242 F.3d at 1385. "In holding an invention obvious in view of a combination of references, there must be some suggestion, motivation, or teaching in the prior art that would have led a person of ordinary skill in the art to select the references and combine them in the way that would produce the claimed invention." *Id.* The Defendants argue in their responses and surreplies that a number of publications either alone, or in combination, render both the '468 and '540 patents obvious.

1. Baker Tools

Both Defendants argue in their briefs that publications describing Baker Oil Tools' ("Baker") Prime Fiberglass Packer[5] and AD-Type Fiberglass Packer (collectively the "Baker tools") render obvious claims 1 and 30 of the '468 patent and claims 1 and 2 of the '540 patent. Baker's 1968 Special Products Manual discloses the Baker Fiberglass Packer and a 1968 World Oil Advertisement (collectively "Baker references") discloses both Baker tools. The Baker references predate the filing of the '468 and '540 patents by more than twenty years, and the patent examiner did not consider these materials during the prosecution of

[5]For the purposes of this opinion, packers and bridge plugs are considered to be similar downhole oil well tools.

Halliburton's patents-in-suit. These references appear to raise a substantial question about the validity of some of the relevant claims of Halliburton's patents.

The components of the Baker tools include a packing element and a plurality of slips disposed around a center mandrel. All components of the Prime Fiberglass Packer are constructed of non-metallic substances, and the mandrel of the AD-Type Fiberglass Packer is made of a non-metallic substance. Halliburton argues that the Baker tools could not be positioned into a locking, sealing engagement with the well bore. However, the function of the slips is to "bite into the casing" or lockingly engage the well bore, and the packing element is designed to sealingly engage the well bore. The incorporation of these design elements coupled with the description in the Special Products Manual for "running" or setting the tool suggest that the Baker tools could be positioned into a locking, sealing engagement with the well bore.

Halliburton further argues that the Baker tools do not have the necessary element of a slip support on the opposite side of the cone as part of the slip means. As discussed above, a slip support opposite the cone is not a necessary element of "slip means" for the purposes of deciding this motion. Thus, the Baker tools' slip mechanism is consistent with the defined term "slip means." The Baker references, therefore, anticipate or render obvious claim 30 of the '468 patent and claims 1 and 2 of the '540 patent.

The Baker references do not disclose the drill out element in claim 1 of '468 patent. The Defendants argue that persons skilled in the art knew to drill out bridge plugs from well bores if the tools became stuck. The Baker references coupled with this general knowledge

do not render obvious Halliburton's method claim. Claim 1 of the '468 patent describes a process for routinely setting a well tool and then drilling it out. The abnormal drill out of a malfunctioning bridge plug is not a customary part of the process for setting the Baker tools nor is there any suggestion in the references themselves that the Baker tools could or should be drilled out. The Baker references and the knowledge of abnormal plug drill outs do not render obvious claim 1 of the '468 patent.

The Defendants also argue that the Baker references, combined with other prior art, such as United States Patent Number 4,708,202 (the " '202" patent), suggest routine drill out of bridge plugs. The '202 patent and the '266 patent discussed above disclose that drilling out downhole tools, such as packers and bridge plugs, constructed of non-metallic components is desirable. These patents specifically state that non-metallic components improve the drillabillity of well tools. The coupling of the Baker references with either the '202 patent or the '266 patent renders claim 1 of the '468 patent obvious.

2. Other Prior Art References

The Defendants also argue that other prior art references, taken together with the Baker references, render the relevant claims of the patents-in-suit obvious. The Defendants state that the '202 patent, entitled "Drillable Well-Fluid Flow Control Tool," issued on November 24, 1987 discloses every element and limitation of Halliburton's claim 1 and 30 of the '468 patent and claims 1 and 2 of the '540 patent except the non-metallic mandrel or slips. The Baker references, Defendants argue, coupled with the '202 patent render these claims obvious. Additionally, the '202 patent itself discusses "forming a number of the

components of the tool from [non-metallic substances]" to improve the tools' drillability. App. Pl. at 000130, col. 7, l. 23-27. This language suggests forming tool components, such as the mandrel or slips, from non-metallic substances, and the Baker Special Products Manual discloses packers constructed entirely of non-metallic substances. The '202 patent and the Baker references, therefore, raise a substantial question as to the validity of claims 1 of the '468 patent and claims 1 and 2 of the '540 patent.

Defendants also argue United States Patent Number 3,306,366 (the " '366 patent"), entitled "Well Packer Apparatus," issued on February 28, 1967 discloses the common geometry of well tools with slips above and below the packing means that act in opposite directions. This slip geometry is consistent with the '266 patent discussed above. The upper slip assembly prevents the plug from moving upward in the well and the lower slip assembly prevents downward movement. The combination of the Baker references with the slip geometry disclosed in both the '875 and '266 patent appears to raise a substantial question as to the validity of claim 3 of the '540 patent.

Whether a claim would have been obvious within the meaning of 35 U.S.C. § 103 is a question of law based on underlying findings of fact including: the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art. In light of these factual determinations discussed above, the relevant claims of Halliburton's patents-in-suit are obvious. Secondary considerations such as commercial success, long felt but unsolved needs, failure of others, copying and unexpected results may also be utilized "to give light to the circumstances surrounding the

origin of the subject matter sought to be patented." *Graham v. John Deere Co.* U.S. 1, 17-18 (1966). These secondary factors favor a finding of nonobviousness of Halliburton's patents-in-suit: Halliburton's FAS DRILL® tools have enjoyed commercial success; the marketplace needed an easily drillable bridge plug; others, such as Mr. Harris, attempted but failed in designing and testing such a drillable tool; and Halliburton has presented evidence of the alleged copying of its FAS DRILL® tools by the Defendants. However, the factual determinations pertaining to the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art overcome the secondary considerations. The Defendants, therefore, have raised a substantial question regarding the obviousness of the relevant claims of Halliburton's patents-in-suit.

III. Conclusion

The Defendants have shown a substantial question regarding the validity of relevant claims of the patents-in-suit. The '266 patent anticipates claims 1 and 30 of the '468 patent and claims 1-3 of the '540 patent. The Baker references alone anticipate or render obvious claim 30 of the '468 patent and claims 1 and 2 of the '540 patent. The Baker references taken together with the '202 patent or '266 patent render obvious claim 1 of the '468 patent and claims 1 and 2 of the '540 patent. Lastly, the Baker references and the '366 or '266 patent render obvious claim 3 of the '540 patent.

Halliburton has not show that the Defendants' attacks on its patents lack substantial merit. Thus, Halliburton has not demonstrated a likelihood of success on the merits of its claims at trial. Therefore, Halliburton's motion for a preliminary injunction is denied.[6]

SIGNED this 4 day of March, 2003.

David C. Godbey
United States District Judge

[6]In light of this order, (1) Halliburton's motion for expedited discovery filed on June 27, 2002, (2) Halliburton's motion for temporary restraining order filed on June 27, 2002, (3) Weatherford's and BJ's motion for enlargement of time filed on July 1, 2002, (4) Halliburton's motion to strike filed on August 27, 2002, (5) Weatherford's motion to strike the declarations in support of Halliburton's requests for preliminary relief filed on September 11, 2002, and (6) Weatherford's motion to strike Halliburton's consolidated response to Defendants' sur-replies or, alternatively, motion for leave to file a reply brief filed on September 11, 2002 are denied as moot.

ORIGINAL

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

HALLIBURTON ENERGY SERVICES, INC.,	§	
	§	
Plaintiff,	§	
	§	
v.	§	Civil Action No. 3-02-CV-1347-N
	§	
WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY,	§	
	§	
Defendants.	§	

ORDER

Before the Court is Plaintiff Halliburton Energy Services, Inc.'s ("Halliburton") motion for reconsideration of the Court's memorandum opinion and order, entered March 5, 2003, ("Order") denying Halliburton's motion for preliminary injunction. Though Halliburton identifies neither the procedural basis nor the standard for its motion, the Court will consider it a motion to alter or amend judgment pursuant to Federal Rule of Civil Procedure 59(e). *See Lavespere v. Niagra Machine & Tool Works, Inc.*, 910 F.2d 167, 173 (5th Cir. 1990), *cert. denied*, 510 U.S. 859 (1993). Halliburton argues in its motion that it is entitled to reconsideration because of an intervening change in the law controlling the Court's denial of its motion for preliminary injunction, citing *Amgen, Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313 (Fed. Cir. 2003).[1] The Court denies Halliburton's motion to

[1]Halliburton offers additional grounds for reconsideration in its reply, however, the grounds are not proper under Rule 59(e), *see In re Benjamin Moore & Co.*, 318 F.3d 626, 629 (5th Cir. 2002), and the Court will not consider an argument raised for the first time in a reply

alter or amend judgment because the Federal Circuit's decision in *Amgen* did not change the controlling law.

The Court denied Halliburton's motion for preliminary injunction, in part, because Defendant Weatherford International, Inc. ("Weatherford") raised a substantial question regarding the validity of the patents-in-suit; Weatherford argued that United States Patent Number 1,684,266, entitled Bridging Plug, issued on September 11, 1928, (the " '266 patent") anticipated the patents-in-suit. Because Halliburton did not show that Weatherford's attack on its patents lacked substantial merit, Halliburton could not demonstrate a likelihood of success on the merits of its claims, and the Court denied its motion for preliminary injunction.

Halliburton now argues and offers evidence for the first time that the '266 Patent does not anticipate the patents-in-suit because it is not enabling. Specifically, Halliburton asserts that the '266 Patent is not enabling because the tool disclosed does not seal the well bore. Halliburton's excuse for its belated argument is that the law pertaining to the party with the burden of showing that the '266 Patent is or is not enabling changed; Halliburton states that it relied upon the treatise *Chisum on Patents* for the proposition that a patent validity challenger must initially bear the burden of producing some evidence that a reference, such as the '266 Patent, is enabling. *See* CHISUM ON PATENTS § 3.04 [1][b][v], at 3-102 to 3-103 (2002) ("Chisum"). The Federal Circuit in *Amgen*, Halliburton argues, changed Professor Chisum's understanding of the law and held that a patentee bears the burden of offering

---

brief. *See Lacher v. West*, 147 F. Supp. 2d 538, 540 & n.2 (N.D. Tex. 2001).

evidence of whether prior art, cited as evidence of invalidity, fails to enable the claimed invention. *See Amgen*, 314 F.3d at 1355. Halliburton's argument is unpersuasive.

First, though Professor Chisum is an expert in the area of patent law and his treatise an esteemed secondary source, it does not constitute *controlling* precedent; though courts may choose to adopt his rationale, they are by no means bound by it. Second, Halliburton's *Chisum* reference does not state definitively that the law pertaining to the burden of proof on enablement is settled; quite to the contrary, *Chisum* cites several district court opinions that presume a prior art reference to be enabling, thereby requiring the patentee to initially produce some evidence that the prior art fails to enable the claimed invention. CHISUM at n. 53. *Chisum* then disagreed with the cited district court opinions and, by analogizing to presumptions in other legal contexts, hypothesized that the Federal Circuit would require a validity challenger to first produce some evidence that a prior art reference is enabling. Thus, Halliburton's argument that it was misled by *Chisum* or even the state of controlling law is unpersuasive; *Chisum* acknowledged the different approaches to the burden of proof on the enabling quality of a prior art reference and gave its best guess on what the Federal Circuit would decide.

Third, even assuming Halliburton was somehow confused or misled as to the controlling law, the illustrative case cited in *Chisum* for the proposition that a validity challenger must first produce some evidence that a reference is enabling states:

> Since the burden is always on the challenger to show invalidity by clear and convincing evidence, once [the accused infringer] has shown that each and every claim is cited in [a cited prior art] reference, i.e., identity, [the patentee] only has the burden of producing some material evidence which places the

> enablement of the reference in question. Once it has done so, [the accused infringer] must show by clear and convincing evidence that the reference was, in fact, enabling.

CHISUM (internal citations omitted, quoting *Abbott Labs. v. Diamedix Corp.*, 969 F. Supp. 1064 (N.D. Ill. 1997)). Contrary to the relevant case law, Halliburton did not produce some material evidence which placed the enablement of the reference in question. Indeed, it did not even raise this issue in its briefs, rather only in oral argument without evidentiary support.

Fourth, the holding in *Amgen* is not directly on point and thus is not controlling law within the meaning of Rule 59(e). The court and the parties in *Amgen* agreed that under section 282, 35 U.S.C. § 282, the claims of a prior art patent are presumed enabling. Here the claims of the '266 Patent disclose that the tool seals the well bore. *See* '266 Patent, claims 2, 3, and 6. The Federal Circuit in *Amgen* addressed the presumption of enablement in the context of a patent's unclaimed disclosures. Therefore, *Amgen* is not controlling law for the purposes of Rule 59(e). Fifth, *Amgen* did not purport to change the law pertaining to the presumption of enablement for prior art references, rather the Federal Circuit relied on established precedent. *See Amgen,* 314 F.3d at 1355.

Lastly, in applying for the extraordinary remedy of preliminary injunction, Halliburton had the burden of establishing a likelihood of success on the merits. As part of that burden, Halliburton had to show that Weatherford's attack on its patents lacked substantial merit. Notwithstanding this burden, Halliburton failed to raise in its briefs or to produce any evidence on the failure of the '266 Patent as an enabling disclosure. Halliburton cannot now blame Professor Chisum for its failure to offer evidence that the '266 Patent was not

enabling. Halliburton's motion to alter or amend judgment is therefore DENIED.[2]

SIGNED this 26 day of August, 2003.

David C. Godbey, District Judge

[2] In light of this Order, Halliburton's motion for admission of the '266 Model, filed on May 12, 2003, is DENIED, Defendant BJ Services Company's motion to strike, filed April 7, 2003, is DENIED as moot, and Weatherford's motion for leave to file its submission of additional rebuttal evidence in response to Halliburton's motion for reconsideration, filed August 22, 2003, is DENIED as moot.

Exhibit

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

HALLIBURTON ENERGY SERVICES, INC.,

Plaintiff,

v.

WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY,

Defendants.

CIVIL ACTION NO. 3-02-CV-1347-N

JUDGE GODBEY

NOTICE OF APPEAL

Notice is hereby given that Halliburton Energy Services, Inc., Plaintiff in the above-named case, hereby appeals to the United States Court of Appeals for the Federal Circuit from the following:

1. The Memorandum Opinion and Order entered on March 4, 2003, in which the Court denied Plaintiff's Motion for a Preliminary Injunction and Plaintiff's Motion for a Temporary Restraining Order , all prior orders and rulings leading up to it, and Plaintiff's requests presented in and by Plaintiff's pleadings and evidence associated with those motions.

2. The Order entered on August 26, 2003, denying Plaintiff's Motion for Reconsideration of the Memorandum Opinion and Order entered March 4, 2003, all prior orders and rulings leading up to it, and Plaintiff's requests presented in and by Plaintiff's pleadings and evidence associated with that motion.

Plaintiff expressly reserves its rights to appeal from and urge against any adverse decisions or rulings made by the Court, directly or indirectly, in either of the above entered opinions and/or orders.

Dated: September 24, 2003

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04-1018

IN THE

UNITED STATES COURT OF APPEALS

FOR THE FEDERAL CIRCUIT

HALLIBURTON ENERGY SERVICES, INC.,

Plaintiff-Appellant,

v.

WEATHERFORD INTERNATIONAL, INC.,

Defendant-Appellee,

and

BJ SERVICES COMPANY,

Defendant-Appellee.

Appeal from the United States District Court for the Northern District of Texas in case no. 02-CV-01347, Judge David C. Godbey.

BRIEF OF PLAINTIFF-APPELLANT HALLIBURTON ENERGY SERVICES, INC.

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December 15, 2003

CERTIFICATE OF INTEREST

Counsel for Appellant Halliburton Energy Services, Inc. certifies the following:

1. The full name of every party or amicus represented by me is:

   Halliburton Energy Services, Inc.

2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by me is:

   N/A

3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party or amicus curiae represented by me are:

   DII Industries, LLC
   Halliburton Company

4. The names of all law firms and the partners or associates that appeared for the party or amicus now represented by me in the trial court or agency or are expected to appear in this court are:

   CRUTSINGER & BOOTH
   John F. Booth
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Date: December 15, 2003

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TABLE OF CONTENTS

TABLE OF AUTHORITIES v

STATEMENT OF RELATED CASES ix

STATEMENT OF JURISDICTION 1

I. STATEMENT OF THE ISSUES 2

II. STATEMENT OF THE CASE 3

- A. Preliminary Statement 3
- B. Nature of the Case, Course of Proceedings, and Disposition Below 5
- C. Statement of Relevant Facts 6
  - 1. Background of the Relevant Technology 6
    - a. Fracturing Procedures 6
    - b. Downhole Tools for Plugging the Well Bore 7
    - c. The Problem Solved by HES's Patents 8
  - 2. HES's Revolutionary FAS DRILL® Tools 13
  - 3. The HES Patents 15
    - a. The Claims at Issue 15
    - b. The Patent Specifications 17
      - (1) Overview of the Inventions 17
      - (2) "Packers" and "Bridge Plugs" 20
      - (3) "Slip Means" 22
      - (4) "Packing Means" 24
      - (5) "Locking, Sealing Engagement" 25

c. The Prosecution Histories 27

4. The Accused Products 29

5. HES's Irreparable Harm 32

6. The Asserted Prior Art 32

a. U.S. Patent No. 1,684,266 to Fisher et al. (1928) 32

b. The 1968 Baker References 36

c. U.S. Patent No. 3,306,366 to Muse (1967) 38

d. U.S. Patent No. 4,708,202 to Sukup et al. (1987) 38

7. The District Court's Decisions 39

III. SUMMARY OF THE ARGUMENT 42

IV. ARGUMENT 44

A. Standard of Review 44

B. The District Court Erred in Its Construction of the Claims 45

1. The Law of Claim Construction 45

2. "Slip Means Disposed on said Mandrel for Grippingly Engaging said Well Bore When in a Set Position" 46

3. "Packing Means Disposed on said Mandrel for Sealingly Engaging said Well Bore When in a Set Position" 49

4. "Disposed On" 50

5. "Positioning said Downhole Tool into Locking, Sealing Engagement with said Well Bore" 52

C. The District Court Erred in Finding a Substantial Question Regarding the Novelty of the Claimed Inventions 55

D. The District Court Erred in Finding a Substantial Question Regarding the Obviousness of the Claimed Inventions 58

1. The District Court Failed to Properly Consider Objective Evidence of Nonobviousness in Its Analysis 58

2. The Record Taken as a Whole Establishes that The Cited Prior Art Fails To Teach or Suggest The Inventions Claimed in HES's Patents 59

E. The Court Should Direct the District Court to Enter an Order Preliminarily Enjoining the Appellees 65

1. HES has Made a Strong Showing of a Likelihood of Success in Proving Infringement 65

2. HES's Presumption of Irreparable Harm 66

3. The Balance of Hardships Lies in HES's Favor 67

4. The Public Interest Supports the Grant of a Preliminary Injunction Order 68

V. CONCLUSION 68

TABLE OF AUTHORITIES

CASES

Amgen, Inc. v. Hoechst Marion Roussel, Inc.,
314 F.3d 1313 (Fed. Cir. 2003) 42

Applied Materials Inc. v. Advanced Semiconductor Materials Am., Inc., 98 F.3d 1563 (Fed. Cir. 1996) 60

Bell & Howell Document Mgmt. Prods. Co. v. Altek Sys.,
132 F.3d 701 (Fed. Cir. 1997) 67

Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp.,
320 F.3d 1339 (Fed. Cir. 2003) 64

Brookhill-Wilk 1, L.L.C. v. Intuitive Surgical, Inc.,
334 F.3d 1294 (Fed. Cir. 2003) 45, 49

Creo Prods., Inc. v. Presstek, Inc.,
305 F.3d 1337 (Fed. Cir. 2002) 48

Exxon Chem. Patents, Inc. v. Lubrizol Corp.,
64 F.3d 1553 (Fed. Cir. 1995) 53

Graham v. John Deere Co.,
383 U.S. 1, 17-18 (1966) 41, 44, 59

H.H. Robertson Co. v. United Steel Deck, Inc.,
820 F.2d 384 (Fed. Cir. 1987) 67

Heidelberger Druckmaschinen v. Hantscho Commercial Products, Inc.,
21 F.3d 1068 (Fed. Cir. 1994) 62

Interconnect Planning Corp. v. Feil,
774 F.2d 1132 (Fed. Cir. 1985) 64

K Mart Corp. v. Cartier, Inc.,
486 U.S. 281 (1988) 52

Kemco Sales, Inc. v. Control Papers Co.,
208 F.3d 1352 (Fed. Cir. 2000) 45, 46

Lemelson v. TRW, Inc.
760 F.2d 1254 (Fed. Cir. 1985)....................51, 53

Life Techs., Inc. v. Clontech Labs., Inc.,
224 F.3d 1320 (Fed. Cir. 2000)....................63

Lindeman Maschinenfabrick GMBH v. American Hoist and Derrick Co.,
730 F.2d 1452 (Fed. Cir. 1984)....................58

In re Lundberg,
244 F.2d 543 (CCPA 1957)....................48

Markman v. Westview Instruments, Inc.,
52 F.3d 967 (Fed. Cir. 1995) (en banc),
aff'd, 517 U.S. 370 (1996)....................45, 67

Mas-Hamilton Group v. La Gard, Inc.,
156 F.3d 1206 (Fed. Cir. 1998)....................46

Micro Chem., Inc. v. Great Plains Chem. Co.,
194 F.3d 1250 (Fed. Cir. 1999)....................46

Modine Mfg. Co. v. United States Int'l Trade Comm'n,
75 F.3d 1545 (Fed. Cir. 1996)....................60

Northrop Grumman Corp. v. Intel Corp.,
325 F.3d 1346 (Fed. Cir. 2003)....................47

Oakley, Inc. v. Sunglass Hut Int'l,
316 F.3d 1331 (Fed. Cir. 2003)....................44

In re Piasecki,
745 F.2d 1468 (Fed. Cir. 1984)....................59

PPG Industries, Inc. v. Guardian Industries, Corp.,
75 F.3d 1558 (Fed. Cir. 1996)....................68

Purdue Pharma L.P. v. Boehringer Ingelheim GmbH,
237 F.3d 1359 (Fed. Cir. 2001)....................67

Saes Getters, S.p.A. v. Ergenics, Inc.,
816 F. Supp. 979 (D.N.J. 1992),
aff'd without opinion, 989 F.2d 1201 (Fed. Cir. 1993)....................68

Smith, Int'l, Inc. v. Hughes Tool Co.,
718 F.2d 1573 (Fed. Cir. 1983).. 68

Specialty Composites v. Cabot Corp.,
845 F.2d 981 (Fed. Cir. 1988).. 66

Tate Access Floors, Inc. v. Maxcess Technologies, Inc.,
222 F.3d 958 (Fed. Cir. 2000).. 66

Teleflex, Inc. v. Ficosa N. Am. Corp.,
299 F.3d 1313 (Fed. Cir. 2002).. 63

Transclean Corp. v. Bridgewood Services, Inc.,
290 F.3d 1364 (Fed. Cir. 2002).. 55

Unidynamics Corp. v. Automatic Prods. Int'l,
157 F.3d 1311 (Fed. Cir. 1998).. 46, 49

Vulcan Eng'g Co. v. Fata Aluminum, Inc.,
278 F.3d 1366 (Fed. Cir.), *cert. denied*, 537 U.S. 814 (20002)................ 60

Winner Int'l Royalty Corp. v. Wang,
202 F.3d 1340 (Fed. Cir. 2000).. 63

Yamanouchi Pharm. Co. v. Merck & Co.,
231 F.3d 1339 (Fed. Cir. 2000).. 64

FEDERAL STATUTES

28 U.S.C. § 1291(a)(1) and (c)(1) 1

28 U.S.C. § 1331 1

28 U.S.C. § 1338(a) 1

28 U.S.C. § 2107 1

35 U.S.C. § 112, ¶ 2 48

35 U.S.C. § 112, ¶ 6 .... 2, 3, 42, 43, 46, 48, 51

FEDERAL RULES

FED. R. APP. P. 4(a) 1

OTHER AUTHORITIES

Webster's Ninth New Collegiate Dictionary (1985) 50, 54

STATEMENT OF RELATED CASES

This Court has not previously heard any other appeal in or from the same civil action or proceeding in the lower court.

There are no cases known to be before this Court or before any other court that will directly affect or be directly affected by this Court's decision in the pending appeal.

STATEMENT OF JURISDICTION

The U.S. District Court for the Northern District of Texas has subject matter jurisdiction over the claims for patent infringement pursuant to 28 U.S.C. §§ 1331, 1338(a).

This Court has exclusive jurisdiction over this appeal pursuant to 28 U.S.C. § 1291(a)(1) and (c)(1). A timely notice of appeal was filed on September 24, 2003 in accordance with 28 U.S.C. § 2107 and Rule 4(a) of the Federal Rules of Appellate Procedure.

I. STATEMENT OF THE ISSUES

1. Whether the district court erred in adopting impermissibly broad claim constructions that are inconsistent with the plain language of the claims, the patents' specifications, their prosecution histories, and the mandate of 35 U.S.C. § 112, ¶ 6.

2. Whether the district court erred in finding a substantial question concerning claim validity when those claims, as properly construed, were not anticipated by the prior art.

3. Whether the district court erred in finding a substantial question concerning claim validity when those claims, as properly construed, would not have been obvious because, *inter alia*, the prior art taught away from the claimed combinations and the court's determination was made before and independent of any consideration of the patentee's compelling objective evidence of nonobviousness.

4. Whether the district court erred in denying a preliminary injunction when the record demonstrates as a matter of law that (1) the patentee made a strong showing that one or more of its patent claims are valid and (2) the other legal requirements for a preliminary injunction have been satisfied.

II. STATEMENT OF THE CASE

A. Preliminary Statement

Plaintiff-Appellant Halliburton Energy Services, Inc. ("HES") was denied its right to a preliminary injunction for one overriding reason: the district court misconstrued each of the three asserted claims of the patents-in-suit.

For example, the district court failed to understand and to correctly apply 35 U.S.C. § 112, ¶ 6, when construing HES's apparatus claims. As a result, the district court erroneously construed claim terms such as "slip means . . . for grippingly engaging" in a vacuum, *sua sponte* adopting constructions of such terms that were so broad as to read upon any prior art tool that included slips. The patent specifications, however, clearly define and link "slip means" to specifically recited combinations of structural elements (including a slip wedge, slips, and a slip support) that cooperatively interact to perform the claimed functions and that are not disclosed in the allegedly anticipatory prior art.

The court similarly gave an improperly broad construction to the "packing means" in one of the apparatus claims by failing to construe it in accordance with section 112, ¶ 6. The court further compounded its error by effectively erasing from the claims the limitation that the "slip means" and "packing means" each be "disposed on" the tool's mandrel.

Moreover, the district court failed to appreciate the significance of language added to HES's method claim during prosecution to require the step of positioning the recited tool in "locking, sealing engagement" with the well bore. This language distinguishes the claimed method from prior art methods that merely temporarily positioned a tool within a bore and/or those that do not seal off one well zone from another. Based on its overbroad construction, the court erroneously found the method claim to be anticipated by art that did not provide both locking and sealing engagement.

While the district court, in the alternative, concluded that certain prior art raises a substantial question concerning the obviousness of HES's patent claims, that analysis was fundamentally flawed by its improper claim construction. The references not only fail to teach or suggest the properly construed claimed inventions, they actually teach away from them. Moreover, the court erred by arriving at a conclusion of obviousness *before* considering HES's objective evidence of nonobviousness. This evidence, which the district court denigrated as being "secondary," includes the significant commercial success of HES's patented tools, the long-felt need for the claimed invention, the failed attempts of others, peer recognition, the tremendous cost savings achieved by the invention, and Appellees' decision to copy HES's patented inventions.

Appellees' ongoing infringement has caused HES to lose significant sales and contracts for its patented drillable tools and related products and services. Having reaped where they have not sown, Appellees offer their infringing tools at a lower price, forcing HES to cut its prices in order to compete in the marketplace. HES has been irreparably harmed by such actions, and the public interest in enforcing valid and infringed patents strongly supports the imposition of a preliminary injunction in this case.

B. Nature of the Case, Course of Proceedings, and Disposition Below

HES is the owner by assignment of U.S. Patent Nos. 5,271,468 ("the '468 patent") (A49-65) and 5,224,540 ("the '540 patent")(A66-82). HES sells to well operators and owners well tools and services utilizing the inventions disclosed and claimed in these patents. (A2; A593-97 at ¶¶ 3-15.)

Defendant-Appellee Weatherford International, Inc. ("Weatherford") and Defendant-Appellee BJ Services Company ("BJ"), collectively referred herein as "Appellees," also provide equipment and services to customers. (A2.)

On June 27, 2002, HES sued Appellees for infringement of at least claims 1, 2, 30-32, and 73 of the '468 patent and claims 1-5 of the '540 patent. (A100-104.) Motions for a temporary restraining order and a preliminary injunction accompanied the complaint. (A36 at 5; A500-02.) During the pendency of the

motions, the case was reassigned from Judge Jorge A. Solis to newly confirmed Judge David C. Godbey. (A42 at 54.)

Judge Godbey held a non-evidentiary hearing on September 19, 2002. (A44-45 at 80, 82; A1872-1931.) On March 4, 2003, Judge Godbey denied HES's motion, finding that a substantial question exists regarding the validity of the asserted claims in the patents-in-suit. (A1-20.) On August 26, 2003, Judge Godbey denied HES's motion for reconsideration. (A21-25.)

C. Statement of Relevant Facts

1. Background of the Relevant Technology[1]

a. Fracturing Procedures

Oil wells are typically drilled into the earth using large drilling rigs capable of lifting and rotating long, heavy strings of drill pipe with a drill bit at the end. Such wells can penetrate thousands of feet down and pass through several discrete oil-and-gas bearing production formations or pay zones. (A2, A676.) One of the largest costs in drilling a well is the day rate paid by the operator for the drilling rig, which can run up to $250,000 per day. (A1114.) Accordingly, operations that can save rig time result in tremendous operator savings.

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[1] For a brief discussion of well completion, see F. Baker, *A Primer of Oilwell Drilling*, pp. 151-56 (6th ed. 2001)(A652-59).

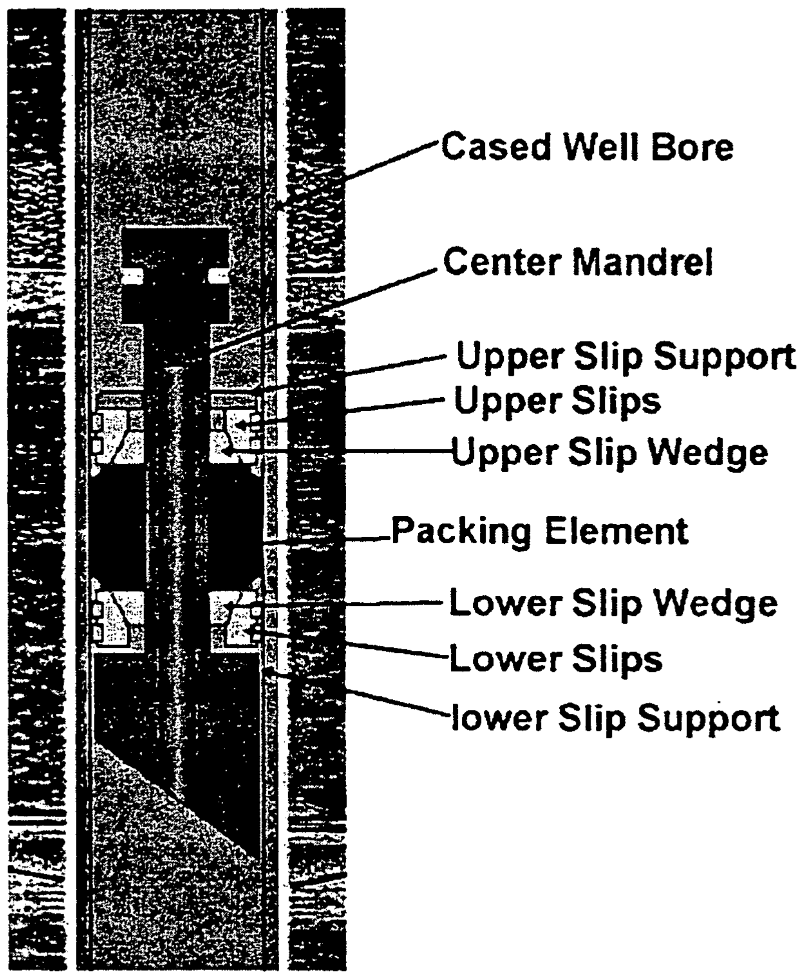
As the well is drilled, strings of relatively large-diameter steel pipe called a casing are lowered into the well bore and cemented into place. (A2; A654.) Next, perforations are made in the casing where it intersects production zones. A completion string of steel pipe is then lowered into the well to complete the well so oil and gas flow into the completion string and to the surface. (A655-56.)

To enhance hydrocarbon flow, operators commonly use a procedure known as fracturing. (A659.) This procedure involves pumping fluids at high pressures, often in the range of 5,000-10,000 pounds per square inch, down a well bore, out through the casing's perforations, and into the surrounding production zone. Pumping such a high-pressure fluid into the zone causes it to crack or fracture. The resulting fractures in the production zone provide flow paths for increased fluid flow. (A659.) Frequently, maximizing production from a well requires that the well operator fracture more than one well bore production zone. (A676-83.) After fracturing a zone, the well bore is plugged with a tool just below the next higher zone to be fractured, isolating the higher zone from the lower zone.

b. Downhole Tools for Plugging the Well Bore

Downhole tools called packers or bridge plugs are used to plug and seal a well bore. (A2.) As illustrated below, such tools usually include a center mandrel, the main structural body on which the tool is built. They also include a packing

element to seal the tool, and anchoring assemblies to hold the tool in place. (A2-3.)



Well Tool Illustration

c. The Problem Solved by HES's Patents

To be successful, a downhole tool must have a rugged structure capable of withstanding high fracturing pressures and resulting high axial forces. (A58, 6:27-34.) This requires the tool to be very durable and be able to be tightly anchored into the well bore. However, after the tool has served its purpose, well operators

want to remove the tool to re-open the well bore. The same structural requirements necessary for the tool to withstand high pressures present problems in the efficient removal of the tool.

Early attempts to solve the problem involve the use of a *retrievable* tool, with a latch-and-release mechanism. Such tools, however, were unreliable, complex, and expensive to use. (A666, 1:28-30.)

A partial solution was to use a *drillable* tool made from metallic materials such as cast iron (A666, 1:52-55), rather than steel. (A2.) Drillable tools are permanently locked in the well and later drilled out. This solution also proved difficult and expensive because the drill out process required heavy drilling equipment and long drilling times. Despite the expense involved, drillable cast iron tools are still used in well service operations because they are less expensive and more reliable than retrievable tools. (A666, 1:28-30.)

In the 1980's, Messrs. Sukup and Harris at the Western Company of North America (BJ's predecessor) attempted to improve the drillability of *drillable* well tools by using non-metallic parts. Harris convinced Western to fund such an R&D project because, if successful, it would solve a "long felt need" for non-metallic drillable tools, "revolutionize the industry," and enjoy "tremendous commercial success." (A1114-15; A1143.) The Western engineers realized that "developing an all-composite retainer was a different ball game from the metal one" and that

one "can't just replace the metallic part with a composite." (A1110; A1116.) Moreover, they recognized that the "critical" components were the mandrel, the slips, and the lower guide. (A1116-17.)

From 1980 to 1984-1985, Sukup and Harris unsuccessfully tried to develop an acceptable all-composite drillable tool. (A1110.) Their proposed solution was a tool design having a single set of double directed slips and ratchets to lock the tool in position. (A1103; A1115-16.) However, when prototypes of this tool were tested, they had "several failures" because the mandrel and cones broke under tension, and the slips would not hold the tool in place. (A1115-20; A1127-28.) In an attempt to salvage something from this work, they decided to develop a tool whose "noncritical" components were non-metallic but which used metallic mandrels, slips, cones, and lower guides. (A1128-29.) Even these tools experienced problems. For example, when prototypes were tested, their cones were crushed. (A1138.) Western never manufactured any of these tools. (A1131.)

Based on their efforts, Sukup and Harris applied for and ultimately obtained U.S. Patent No. 4,708,202 ("Sukup"). (A1606-21.) The Sukup patent, consistent with Western's work, teaches that metallic materials be used for the high-stressed critical tool components (cast iron "mandrel" and "slips") while non-metallic materials be used for the less critical components. Its disclosed tool (see Figure 1 below) employs a single slip assembly design 360. (*See*, *e.g.*, A1612, 2:54-59.)

Although tools using dual slip assemblies were known at the time, the Sukup patent specifically recommended *against* using them. (A1612, 1:65-2:27.) Western also intentionally omitted any discussion of its failed and abandoned all-composite tool from this patent. (A1122-26.)

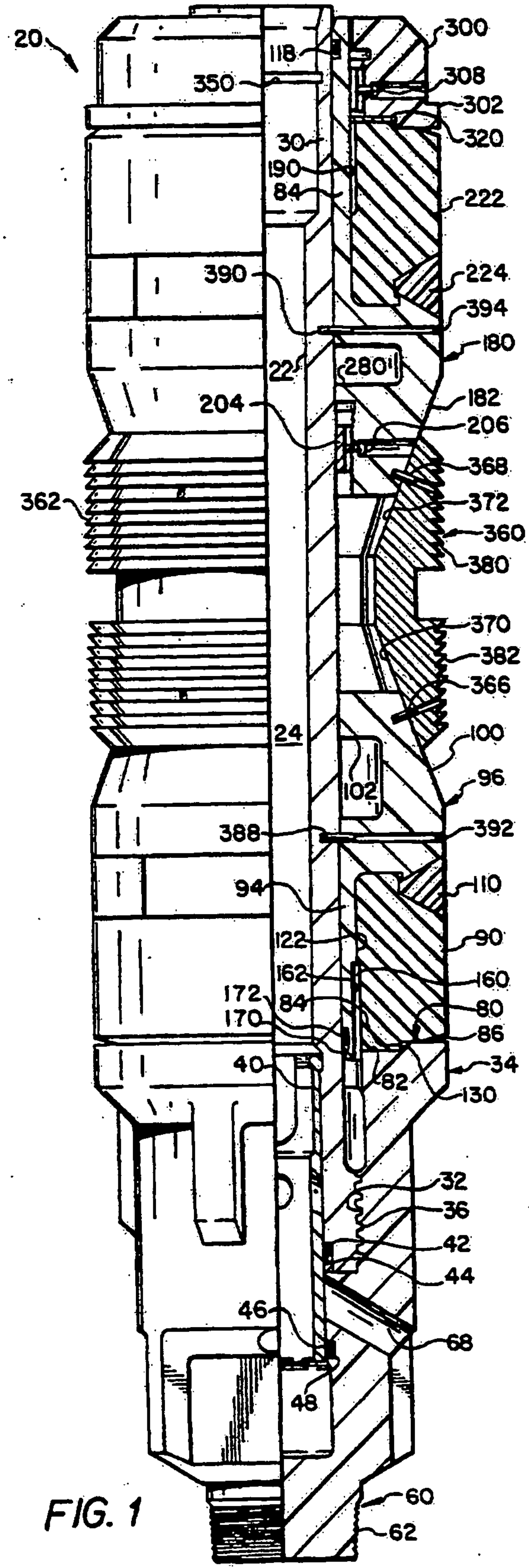

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FIG. 1

Neither BJ, as the Sukup patent owner, nor Weatherford sells or uses such patented tools. Instead, they copied HES's invention.

2. HES's Revolutionary FAS DRILL® Tools

In the late 1980s, HES's engineers began research on drillable tool designs that could overcome the problems experienced with nonmetallic tool components and provide operators with significant savings in rig costs. Despite many drillable tool designs to choose from,[2] these engineers ultimately developed a successful tool design utilizing the very dual slip assembly taught by the Sukup patent as being unworkable. HES's patented packers and bridge plugs withstand the rigors of operating in downhole well conditions, lock the tool in place, and seal the well bore, and yet feature a center mandrel and/or a portion of a slip assembly made of non-metallic composite material to facilitate easy drill out.

In 1994, HES introduced the first of its patented FAS DRILL® tools. (A595 at ¶ 7; *see also* A606-09; A708-11.) Knowing that well operators historically have been reluctant to try unproven tools because of the enormous economic consequence of failure, HES conducted extensive tests to demonstrate the reliability of its new tool and submitted peer-reviewed technical papers describing its test results. (*See* A676-683; A684-692; A712-22.) HES developed a marketing

[2] *See, e.g.*, the art cited on the face of the patents-in-suit. (A49; A66.)

program that included seminars for potential customers and software animations of its tools' operation. (A693.)

HES established that its FAS DRILL® tools successfully operated in the well bore and yet could be later drilled out without the need for an expensive, heavy drilling rig, resulting in significant savings in rig costs. (*See*, *e.g.*, A679 ("rigless completion"); A686-87.) This innovation revolutionized the industry because well operators can dismantle and permanently remove the drilling rigs (with their high daily cost) off the well once the casing is set, saving enormous sums of money. The well operators can later use a less expensive coil tubing drilling unit after fracturing, to quickly drill out the FAS DRILL® tools. (A709-710.) HES's FAS DRILL® tool only requires 15 to 30 minutes for removal (A678), as compared to the greater 4 to 6+ hours required to remove cast iron plugs. (A666, 1:61-64.)

Since 1994, HES has sold tens of millions of dollars worth of FAS DRILL® drillable well tools and related services. (A596 at ¶ 14.) HES's ability to deliver enormous cost savings and increased production with its FAS DRILL® tools gave it a tremendous advantage over competitors that did not employ this new technology. (A596 at ¶ 14.) The FAS DRILL® tools were accepted at premium prices (A596 at ¶ 13) and have since been embraced by the multi-stage frac market. (A595 at ¶ 9; A597 at ¶ 15; A602 at ¶ 35.)

3. The HES Patents

a. The Claims at Issue

To simplify matters for the district court, HES confined its motion for a preliminary injunction to claims 1 and 30 of the '468 patent and claim 3 of the '540 patent. (A4.) They are:

Claim 1 of the '468 Patent

1. A well bore process comprising the steps of:

constructing a downhole tool such that a component thereof is made of a non-metallic material, said tool comprising:

a center mandrel; and

a plurality of slips disposed around said mandrel for grippingly engaging a well bore when in a set position;

wherein, at least one of said mandrel and said plurality of slips is said component;

positioning said downhole tool into locking, sealing engagement with said well bore; and

drilling said tool out of said well bore.

(A63 (emphasis added).)

Claim 30 of the '468 Patent

30. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel made of a non-metallic material; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position.

(A63-64 (emphasis added).)

Claim 3 of the '540 Patent

[1. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said ***slip means*** being at least partially made of a non-metallic material.

2. The apparatus of claim 1 ***characterized as a packing apparatus*** and further comprising ***packing means disposed on said mandrel for sealingly engaging said well bore when in a set position***.]

3. The apparatus of claim 2 wherein said ***slip means*** is an ***upper slip means*** disposed above said ***packing means*** and further comprising a ***lower slip means*** disposed below said ***packing means***,

said ***lower slip means*** being at least partially made of a non-metallic material.

(A82 (emphasis added).)

As can be seen, while the three asserted claims have elements in common, they are nonetheless claims of varying scope and subject matter. Claim 1 of the '468 patent, for example, covers a well bore *process*, whereas the remaining claims cover specific downhole *apparatuses* for use in a well bore. Claim 1 of the '468 patent recites a plurality of slips, whereas the apparatus claims recite a "slip means." Claim 3 of the '540 patent additionally requires the presence of a "packing means."

Claim 30 of the '468 patent on its face requires that the center mandrel be made of a non-metallic material. Claim 3 of the '540 patent is silent as to the

composition of the mandrel, but requires that at least the lower slip means portion of the recited "slip means" be at least partially made of a non-metallic material. Claim 1 of the '468 patent provides, at a minimum, that either the center mandrel or the plurality of slips be non-metallic.

Claim 1 of the '468 patent positively recites the steps of positioning a drillable tool into "locking, sealing engagement" with the well bore and drilling the tool out of the well bore. The apparatus claims recite "slip means disposed on said mandrel for grippingly engaging said well bore when in a set position."

b. The Patent Specifications

The specifications (including the drawings) of the HES patents[3] are highly relevant to the interpretation of the claims because they expressly define the claimed "slip means" and disclose the "packing means."

(1) Overview of the Inventions

The disclosures are directed to downhole well tools and methods of use that utilize easily-drillable, non-metallic components and successfully work in well environments. (A56, 1:12-16; A74, 1:14-19.) The disclosed tool 10 employs non-metallic mandrels, slips, slip supports, or slip wedges that are easily drillable in

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[3] The '540 patent is a continuation-in-part of the '468 patent application. (A66.) Because the two patents contain substantially the same disclosure, reference herein will be made primarily with regard to the '468 patent, with relevant differences in the '540 patent separately noted.

order to improve the speed and efficiency in drilling the apparatus out of a well bore. (A56-57; A74-75.) In use, the tool is releasably connected to a setting device, lowered into the well, and placed into locking, sealing engagement with the well bore.

As set forth in the patent specifications, tool 10 positioned in the locked and sealed position is shown in Fig. 1. (A58, 5:7-12; A76, 5:30-35.)

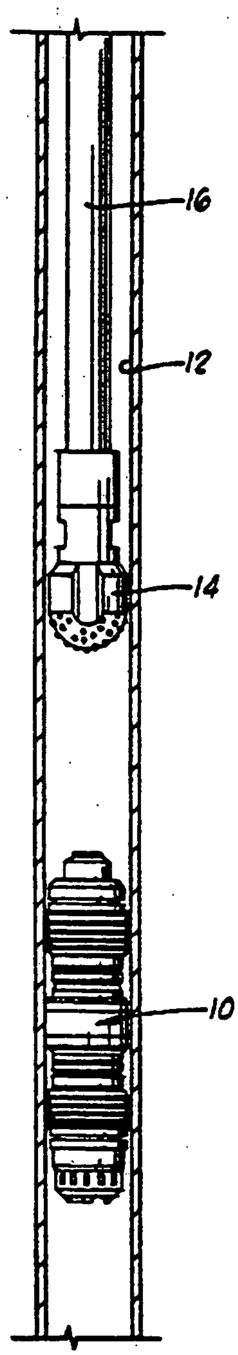


FIG. 1

As illustrated, the tool's packing and anchors are radially expanded in locking, sealing engagement with the walls of the well bore 12 such that it remains

permanently suspended in well bore 12, unconnected to the tubing string or any other setting device. Tool 10 thus isolates the zone above it from the zone below it. When well operations are complete, the tool can be easily drilled out.

(2) "Packers" and "Bridge Plugs"

The patents-in-suit disclose two types of tools, namely "packers" and "bridge plugs." Each packer, illustrated in Figs. 2-6, includes a center mandrel 22 (Fig. 2) and a valve in the bottom of the mandrel that can control flow through the mandrel.

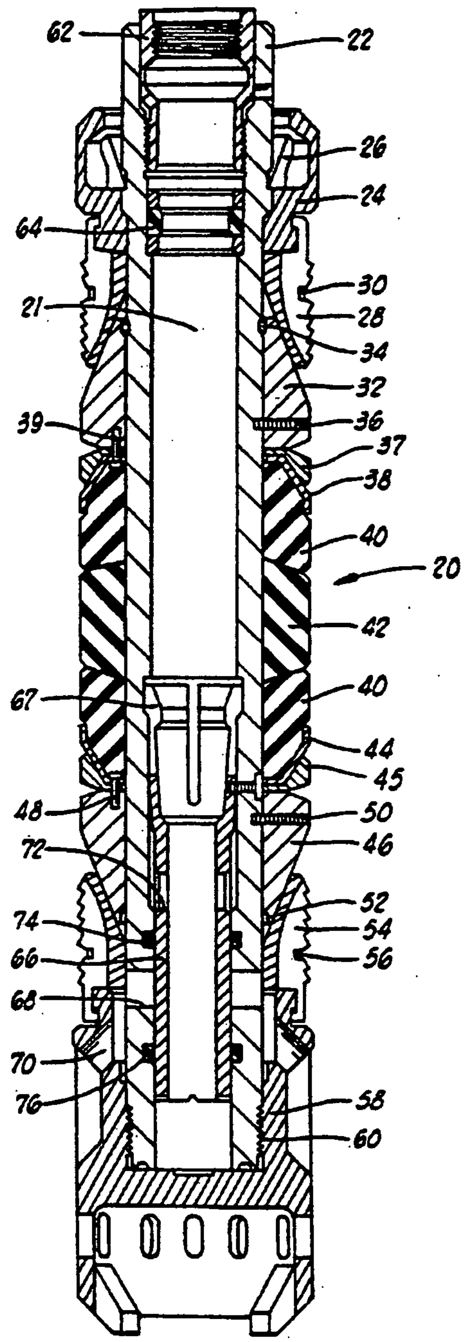


FIG. 2

The bridge plugs, illustrated in Figs. 7 and 8 (A55; A72) include a center mandrel 202 (Fig. 8) and a plug (e.g., 604) in the mandrel that prevents flow through the mandrel.

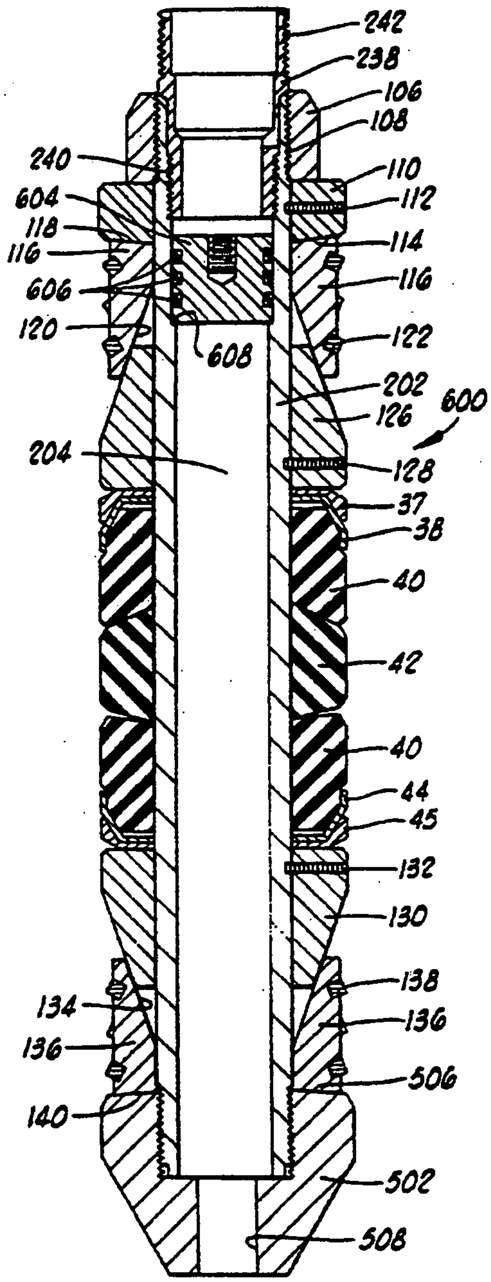


FIG. 8

(3) "Slip Means"

HES's patented inventions are not broadly directed to all types of packers and bridge plugs but instead disclose and claim embodiments that "comprise specific design features to accommodate the benefits and problems of using non-

metallic components, such as plastic." (A59, 7:25-29; A77, 7:52-56.) Specifically, both patents teach that the invention includes "slip means disposed on the mandrel for grippingly engaging the well bore when in a set position." (A57, 3:19-21; A75, 3:23-25.) Each patent defines "slip means" to include a specific combination of structural components.

The '468 patent expressly states that this slip means "may comprise [1] a wedge engaging [2] a plurality of slips with [3] a slip support on the opposite side of the slips from the wedge." (A57, 3:26-28.) In each of the illustrated '468 patent embodiments, the disclosed "slip means" includes all three elements in that precise structural relationship. See Figs. 2, 3A, 4A, 5A, 6A, 7 and 8. Moreover, in each illustrated embodiment, slip assemblies (slip supports, slips, and wedges) are positioned on the mandrel and above and below the packer element to cooperate with the packer element to place the tool in locked, sealing engagement with the well bore.

The '540 patent adopts a slightly narrower definition of "slip means" as "compris[ing] [1] a slip wedge positioned around the center mandrel, [2] a plurality of slips disposed in an initial position around the mandrel and adjacent to the wedge, [3] retaining means for holding the slips in the initial position, and [4] a slip support on an opposite side of the slips from the wedge." (A75, 3:29-34.) The disclosed "retaining means" is either a retaining band around the slips, a

fracturable ring portion integrally formed with the slips, or shear pins. (*See, e.g.*, A77, 8:16-23.) These four elements are illustrated in each of the various embodiments set forth in Figs. 2, 3A, 4A, 5A, 6A, 7, and 8.

Upper and lower slip supports are disclosed in alternative forms. For example, in the embodiment of Figure 2, the upper slip support is lock ring housing 24 (*see, e.g.*, A58, 6:35-39) and in the embodiments of Figures 3-8, it is a spacer ring 110 (*see, e.g.*, A59, 7:50-51). The lower slip support can also be in a variety of forms such as support 58 in Figure 2, "valve housing 144 [Fig. 2] in first packer embodiment 100," and other constructs discussed in the specification. (*See* A62, 13:67-14:6; A81, 15:35-42.) In each instance, the disclosed slip support engages the adjacent slips during setting and forces them to slide along the slip wedges.

(4) "Packing Means"

Both patents disclose the structure of the claimed "packing means" as including two end packer elements 40 and central packer element 42. (A58, 5:40-41; A59, 8:14-15; A76, 5:63-64; A78, 9:12-13.) The specifications state that, during setting, upper slip wedge 126 is forced downward to cause "packer elements 40 and 42 to be squeezed outwardly into sealing engagement with the well bore" and lower slip wedge 130 is forced upward "to provide additional squeezing force on packer elements 40 and 42." (A62, 13:63-66, 14:14-17; A81,

15:31-34, 16:61-64; *see also* A62, 13:36-43, 14:14-16.) The packer elements 40, 42 are annular, axially compressible members disposed directly on mandrel 20 that expand radially outward, when axially compressed, to fill the space between the mandrel and the well bore. See Figs. 2, 3A, 4A, 5A, 6A, 7, and 8.

(5) "Locking, Sealing Engagement"

Both patents disclose a well bore process employing a drillable tool having parts that interact with each other and the well bore wall such that, when removed from the setting apparatus, the tool is in "locking, sealing engagement with said well bore" as required by claim 1 of the '468 patent. The parts and their interaction are substantially the same in each disclosed embodiment.

The claimed "locking, sealing engagement" process is described at length in the HES patents. (*See* A62, 13:20 - 14:40; A80-81, 14:45 - 16:19.) As illustrated by Figure 2, a setting tool pulls upwardly on a tension sleeve 62 mounted to extend into the mandrel 22,[4] while pressing down on a locking ring housing or upper slip support 24. As the mandrel 22 progressively moves upward, the upper slip support 24 engages and forces the upper slips 28 to advance along a tapered surface of the

[4] *Cf.* A58, 5:57-58; A76, 6:12-13. The Sullaway patent, incorporated by reference in the HES patents (*see, e.g.*, A62, 13:23-26), discloses that such tension sleeves are formed of a suitable metal such as brass. (A1594, 2:22-24.)

upper slip wedge 32 and expand outward to engage the well bore.[5] Similarly, as the setting tool applies an upward pull on the mandrel, a lower slip support 58 (carried on the mandrel) also moves upward forcing the lower slips 54 to engage lower slip wedge 46 and expand outward in engagement with the well bore.

The continued application of an upward pull on the mandrel causes the upper and lower slip wedges 32 and 46 to slide relative to the mandrel 22 and into contact with respective end packer elements 40, thereby axially compressing the packer elements 40, 42.[6] The axial compression of the packer elements causes them to expand radially into sealing engagement with the well bore. The packer elements on the mandrel expand to fill the annular space between the mandrel and the well bore, sealing off axial flow and isolating an upper zone from the zone below. At the same time, the packer elements apply axial forces that bias the upper and lower slip wedges 32 and 46 toward the upper and lower slips 28 and 54, respectively, forcing them to more tightly engage the well bore. The cooperation of these elements places the tool into locking, sealing engagement with the well bore.

[5] The '540 patent contains the additional embodiments of Figures 9-11. (*See* A76, 5:53-55; A81, 15:19-30.)

[6] It is this combined interaction of the dual slip assemblies and packing elements that the Sukup patent described as being undesirable.

As the upward pulling force on the setting tool is increased, the tension sleeve 62 shears, allowing the setting tool to be removed from the well bore and leaving the apparatus set in the *locked and the expanded sealed position* within the well bore, as shown in Fig. 1. The tool, in this operational position, can withstand substantial fluid pressures, prevent fluid flow past the tool, and stay in the locked position. Consequently, pressure above or below the tool will not force the apparatus out of the well bore, but instead causes it to be even more tightly engaged with the well bore, the locking action of the opposed slips preventing the apparatus from being unset. (A62, 13:39-43; A80, 14:64-68.)

c. The Prosecution Histories

The original application giving rise to the '468 patent was filed on April 26, 1990 (A1464-88). (A49.) In a first office action dated October 5, 1990 and in a second and final Office Action dated March 18, 1991, the examiner rejected all then-pending claims. (A1511-16; A1529-35.) In each rejection, the Examiner applied one or both of U.S. Patent No. 4,858,687 to Watson et al. ("Watson")(A1635-39) and Western's Sukup patent discussed above (A1606-21) against the claims. The Examiner noted that Watson discloses a plug having components made of drillable plastic. (A1512; A1530.) Similarly, the Examiner explained that Sukup discloses a packer with parts made out of thermoplastic resin to ease the tool's drillability. (A1513; A1531.)

The Examiner relied on additional references for teachings of specific materials when making obviousness rejections. (A1514; A1532.) Also cited during prosecution but not applied was prior art disclosing tools with metallic mandrels and slips configured with opposed dual locking slips above and below a resilient seal (Sullaway)(A1591-1600) and non-locking well tools with nonmetallic mandrels (Armentrout et al.)(A1538-46). (A1504-05, A1509, A1514; A1323-24, A1328, A1335.)

After final rejection, HES filed a continuation-in-part application (A1257-1312) that included new application claims 1-76. (A1257-1312). In a first office action, the Examiner allowed application claims 34-46 (issued as patent claims 30-42) and 48-76 (issued as patent claims 44-72) and objected to application claims 25-27. (A1330-35.) Application claims 1-5, 8, 9, 13, 15, and 18 were rejected as anticipated by Watson. (A1331.) Application claims 1-6, 8-11, 21-24, 28, 29, 32, and 47 were rejected as anticipated by Sukup. (A1333.) Other claims were rejected over Watson and/or Sukup in combination with other references. (A1332-34.)

HES amended the claims and presented argument in favor of their allowance. (A1338-50.) In particular, HES amended application claim 1 to include the step of "positioning said downhole tool into locking, sealing engagement with said well bore." (A1340.) HES explained that this amendment

distinguished over Watson, arguing that Watson (disclosing a slidable wiper component *positioned* in a well) "does not lockingly engage the well bore at all and does not sealingly engage the well bore in the same sense as the present invention." (A1343-44) HES also urged that Watson does show any kind of center mandrel and explained that Sukup does not disclose non-metallic mandrels or slips. (A1346.)

Thereafter, the Examiner allowed all claims except 78-81 and objected to claim 82. (A1351-56.) Claims 78-80 were ultimately cancelled, and application claims 81-82 were amended and allowed to issue as patent claims 74 and 75. (A1357-60.)

The '540 patent was issued in a first office action. (A1450-51.) None of its patent claims were rejected.

4. The Accused Products

In 2001, Weatherford began marketing a line of drillable tools under the name "FracGuard." (A597-98 at ¶ 17.) Around the same time, BJ began marketing a line of drillable tools under the name "Python." (A598 at ¶ 20.) Appellees' tools incorporate the patented aspects of HES's FAS DRILL® tool and infringe HES's patent claims. (See A593-634; A635-51; A694-702.)

The conclusion that Appellees copied HES's patents is inescapable. Like HES's FAS DRILL® tools, Appellees' tools are designed to be placed in locking,

sealing engagement with well bores and to be easily drilled out after use. (A598-99 at ¶¶ 18, 21-23; A636 at ¶¶ 5-6; A637 at ¶ 11(a); A640 at ¶ 15(a).) By Appellees' admission, their tools incorporate center mandrels made of a non-metallic composite material. (A638 at ¶ 11(b); A640 at ¶ 15(b).) Appellees also have not contested that their tools have the claimed upper and lower slip means (multiple slips, a cone for wedging the slips, and a slip support structure on the opposite side of the slips from the cone) disposed on the mandrel, made at least partially of a non-metallic composite material, and located above and below the packing means. (A638-39 at ¶ 11(d), (f); A640-41 at ¶ 15(d), (f); A762 at ¶¶ 8-9.) Appellees' tools also have a packing element that expands to seal against the mandrel and the well bore. (A638 at ¶ 11(c); A640 at ¶ 15(c).) Furthermore, Appellees' tools also employ a retaining means, a fact not disputed by the Appellees below.

Appellees have offered for sale, sold, and continue to sell their FracGuard and Python drillable tools and supervise their installation in wells. (A599 at ¶ 24.) BJ directly infringes HES's method claim by locking in the well and drilling out its Python plugs having non-metallic mandrels. Weatherford's actions and its sales literature induce and contribute to infringement of HES's method claim by customers who buy its FracGuard tools, lock them in wells, and drill them out. The accused products have no substantially noninfringing use and are especially

adapted for use in an infringement. Each Appellee directly infringes the apparatus claims by making, using, offering for sale, and selling their FracGuard and Python tools.

Weatherford made no attempt below to raise a substantial question concerning infringement, electing to focus instead on the question of validity. (A815-16; A1039-40 at n.2.) BJ made no attempt below to argue that its original version of the Python tool (with a thermoplastic mandrel) raised a substantial question concerning the infringement of claims 1 and 30 of the '468 patent, except to assert that it has ceased production of that earlier version. (A763 at ¶ 13.)

The other arguments raised by BJ below did not amount to "substantial" questions of infringement. BJ asserted that its current Python tool design avoids infringement of claims 1 and 30 of the '468 patent because it has inserted a brass tube within its original non-metallic mandrel design. BJ's witness, however, recognized that the brass tube is a component separate from the mandrel, rather than part of the unitary mandrel structure. (A764 at ¶ 15.)

While the Python tool employs non-metallic cones and slip supports, BJ also asserted noninfringement of claim 3 of the '540 patent because its tool contains metal slips. (A762 at ¶¶ 8-9.) BJ's non-metallic cones and slip supports, however, are a part of the claimed slip means and thus satisfy the requirement that a portion of the "lower slip means" be "at least partially made of a non-metallic material."

5. HES's Irreparable Harm

Appellees' marketing of their FracGuard and Python tools has caused HES to suffer millions of dollars of lost sales of patented tools and related services and to lose market share and customer good will. (A599-603 at ¶¶ 24-38.) Appellees have targeted HES's customers by undercutting prices for the patented FAS DRILL® tools. (A599-600 at ¶ 25.) To compete in the market, HES has been forced to lower the prices on its own products and services. (A600 at ¶ 27.) Having enjoyed such lower prices, customer opposition will likely preclude HES from ever returning to historical price levels. (A600 at ¶ 28.)

Left unchecked, Appellees' infringement will only continue to drive prices down, causing further damage to HES. (A603 at ¶ 38.) Appellees' marketing campaigns and predatory pricing have already contributed to HES's plans to institute layoffs of well-servicing employees, and further layoffs and restructuring are anticipated. (A602 at ¶ 37.)

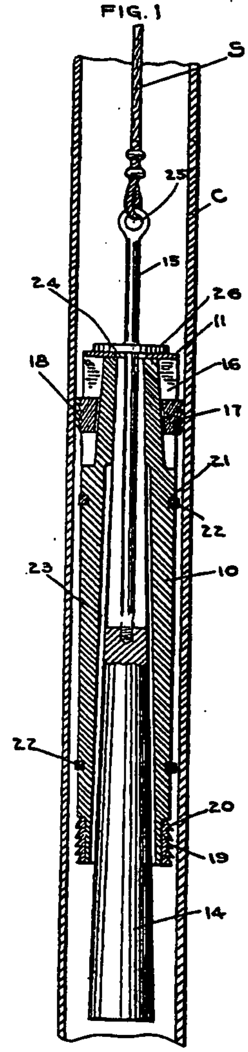
6. The Asserted Prior Art

a. U.S. Patent No. 1,684,266 to Fisher et al. (1928)

Fisher (A1203-06) is directed to a bridge plug and teaches providing a plug "formed of a readily destructible material so that after the plug has been seated within the casing, it will be relatively easy to remove the same for further drilling

operations by a drilling tool." (A1204, lns. 16-21.) Fisher is a paper patent and its tool does not appear to have ever been manufactured or sold.

FIG. 1



As shown, the Fisher tool includes a wood mandrel 14 and longitudinal wooden segments 10. Segments 10 surround mandrel 14 and are held together at their upper ends by a circular disk with slots that carry screws from the segments. See Fig. 5 (A1203). Slidable slips 17 with upwardly directed teeth 18 are carried in slots formed in the outer surface of segments 10. The tool includes stationary

slips 19 at the bottom of the segments 10. Fisher teaches that "slips 17 and 19 are preferably formed of cast iron or any equivalent frangible material which can be easily broken up by a drilling tool." (A1205, lns. 91-95.)

The Fisher tool includes rubber packing rings 22 held in horizontal grooves formed in segments 10, between the upper and lower slips. When the plug is set by pulling upward on a sand line S, the mandrel 14 moves upward, *separating the segments 10 from each other*, and placing at least portions of the rubber rings into contact with the casing. (A1205, lns. 64-69 (emphasis added).) Fisher maintains that when the plug is set, the "rubber rings 22 also engage the casing and are compressed, thus forming a packer or seal to prevent the leakage of fluid between the exterior surface of the segments 10 and the casing." (A1205, lns. 68-73.) Fisher also discloses that its plug "carries" an unidentified "sealing means" that it alleges "will prevent leakage either between the segments 10 and the casing C, or between the sides of adjacent segments which are separated slightly when the segments are expanded." (A1205-06, ln. 128 - ln. 2).

Notwithstanding such assertions, Fisher is inherently incapable of sealing the well bore against leakage. Given Fisher's admission that segments 10 *separate* when the plug is expanded (A1205, lns. 64-69), the inevitable result is that the plug in the expanded position necessarily has axial flow channels permitting axial flow through the plug. There is simply no way for the disclosed rubber bands to expand

radially inward, when put in tension, to fill the resultant gaps between the separated segments. No other sealing means is disclosed. Fisher, therefore, on its face does not disclose the "positioning said downhole tool into locking, *sealing* engagement with said well bore" step of method claim 1 of the '468 patent or a "packing means . . .for *sealingly* engaging said well bore when in the set position" as required by claim 3 of the '540 patent. [Emphasis added.] A model of the Fisher system illustrating this inherent defect was shown to the district court at the oral hearing without objection. (A1892 at 12-25.)

While Fisher discloses slidable slips 17 and stationary slips 19 with teeth that will engage the well bore casing, it does not disclose the slip means of claim 30 of the '468 patent comprising "a *wedge engaging* a plurality of slips with a *slip support on the opposite side* of the slips from the wedge." (A57, 3:26-28 (emphasis added).) Nor does it disclose the similar slip means construct of claim 3 of the '540 patent. Although Appellees argued below (A1048) that the *interior* surfaces of segments 10 are designed in such a way as to form a "conical bore" through the plug complementary to the tapered mandrel 14 (A1204, lns. 90-94), this "conical bore" cannot properly be considered a "slip wedge." The Fisher slips are disposed on the *exterior* side of segments 10 for engagement of the casing (A1204, ln. 105 to A1205, ln. 12.), and thus never "engage" the conical bore on the

interior side of segments 10. Appellees did not even urge that Fisher includes slip supports.

In addition, Fisher's rubber rings and slips are not attached to or "disposed on" mandrel 14 as required by the asserted apparatus claims, but instead are located on segments 10.

b. The 1968 Baker References

A 1968 advertisement for Baker Fiberglass Packers illustrates and describes two different versions of the Baker Fiberglass Packer, both of which are retrievable packers supported from tubing and therefore never locked in a well bore (A845-48.)

According to the advertisement, one version was made entirely of fiberglass and was developed for corrosive fluid problems. (A848; A1064-69.) As shown and described, this tension packer has a mandrel, slips, and a slip wedge (each made of fiberglass) and a packer element. (A848.) Of the two packers shown in the advertisement, the entirely fiberglass packer appears to be the rightmost packer and is believed to be the same packer illustrated and described in a 1968 Baker Oil Tools, Inc. Special Products Manual. (A843-44.) This Manual discloses a *retrievable* tension packer product whose "primary application will be as an injection packer in wells using fiberglass tubing strings." (A844.)

The other tension packer, described as a "less expensive packer" (and referred to by the district court as an AD-Type Fiberglass Packer) combines a fiberglass body with a Kanigen-plated metal setting mechanism. The less expensive packer has a fiberglass mandrel, metallic slips and a slip wedge, and a packer element. (A848.)

The Baker tension packers can never be placed in "locking, sealing engagement with said well bore" as required by claim 1 of the '468 patent. The Baker Manual describes lifting the tubing to "pack off" the packer element (seal). (A844.) The Baker tension packers remain connected to the tubing that applies the lifting force to hold the tool in position. These packers are supported entirely by the tubing connected to the well head. Lacking a locking mechanism, the tension packers would fall down the well if the tubing connection were severed or removed.

The Baker Manual explains how to *retrieve* the tool by exerting a downward force on the connected tubing and then lifting the tool out of the well. (A844.) This is the antithesis of the process set forth in claim 1 of the '468 patent, which requires the claimed locked tool to be subsequently drilled out.

The Baker references also fail to disclose tools utilizing the recited "slip means" of the apparatus claims. They lack the required slip supports on the opposite sides of the slip wedges to lock the slips in place against the wedges. The

slip supports are essential to enable an HES tool to be placed into locked engagement with the well bore.

Mr. Harris was working at Baker when the fiberglass Baker tools were tested. (A1060-61, A1070-83.) These tools experienced failures that included the mandrel breaking. (A1090-93.) The Baker tension packer design was used for a "totally . . . different purpose" and Harris did not use the Baker design in his development work at Western because it would not work as a drillable tool. (A1133-36.) Moreover, he did not cite the Baker tool to the PTO during the prosecution of the Sukup patent because "it won't function in the same way." (A1135.)

c. U.S. Patent No. 3,306,366 to Muse (1967)

Muse (A864-75) discloses a well packer apparatus having a packing structure 23 situated between segmental lower slips 12 and upper segmental slips 28 that act in opposite directions. (A869, 2:39-60.) The Muse system, however, does not suggest that either the center mandrel or the slips should contain non-metallic material.

d. U.S. Patent No. 4,708,202 to Sukup et al. (1987)

Sukup (A1606-21) was cited and applied by the Examiner during the original examination of the '468 patent. Sukup discloses a tool with some parts made out of a thermoplastic resin to facilitate tool drillability. While Sukup stated

that "[t]he present design provides for the forming of a number of the components of the tool from high strength synthetic resins" (A1615, 7:25-27), mandrels or slips were never components that were suggested as appropriate candidates. Sukup's disclosed tool employs a single slip assembly design that locks in place by interlocking teeth on the mandrel and an adjacent lock ring. (*See*, *e.g.*, A1612, 2:54-59; 6:13-26.) As discussed in section II.C.1.c. above, this patent teaches away from the use of a dual slip means in a drillable tool with non-metallic components. (A1612, 1:65 - 2:27.)

7. The District Court's Decisions

The district court denied HES's motion for a preliminary injunction on the ground that a substantial question concerning the validity of the asserted HES patent claims had been raised. (A19-20.) The district court found that the Fisher '266 patent anticipated all of the asserted HES claims. (A7-14.) In so doing, the district court refused to construe the "slip means" in the apparatus claims as including specification-defined components such as a "slip support on the opposite side of the slips from the wedge" that are missing from the Fisher and Baker disclosures. (A10-11.) From the district court's silence, it also appears that "packing means" of claim 3 was likewise construed without reference to the patent specification. The court's broad interpretation of these "means for" elements was never advanced below by the Appellees in their opposition papers. (A9.)

The district court effectively rewrote the claims to require that the claimed slip means and packing means only need be disposed about or near the center mandrel as arguably suggested by Fisher, rather than physically on the center mandrel as the language of the apparatus claims clearly requires. (A13-14.) In addition, the district court construed the limitation of "sealing engagement" to be met if there was some degree of sealing contact, and therefore gave no weight to HES's argument that the Fisher plug, according to its own disclosure, would not in practice sealingly engage the well bore. (A13.)

The district court went on to find that the Baker references (with no slip support) alone anticipated or rendered obvious claim 30 of the '468 patent by using the same erroneous claim construction it had applied to the Fisher patent. (A16.) The court also applied the Baker references against method claim 1, failing to recognize the distinction between merely positioning a retrievable tool in a well and positioning a drillable tool in "locking, sealing engagement," as required by claim 1. Although the drill out step of method claim 1 is not disclosed in the Baker references, the district court *sua sponte* combined Sukup or Fisher[7] with the Baker references. (A17.)

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[7] Weatherford belatedly cited Fisher as "anticipatory" in its surreply brief and never argued it as a section 103 reference. BJ never relied on Fisher in its oppositions to HES's motion for a preliminary injunction.

Although the Baker references do not disclose the presence of a packing means between upper and lower slip means, as required by claim 3 of the '540 patent, the district court found this feature was taught by the Muse or Fisher patents and combined them with the Baker references. (A18.) Finally, the court found that the Sukup patent disclosed all elements of the asserted '468 claims except for the non-metallic mandrel or slips, and concluded that this requirement was obvious in light of allegedly suggestive language in Sukup and the teachings of the Baker references. (A17-18.)

After coming to each of the above conclusions that the asserted prior art raised a substantial question as to the obviousness of each asserted HES claim, the district court then considered the evidence of "secondary" factors favoring a finding of nonobviousness of HES's patent claims. (A18-19.) It expressly found that HES's "FAS DRILL® tools have enjoyed commercial success; the marketplace needed an easily drillable bridge plug; others, such as Mr. Harris attempted but failed in designing and testing such a drillable tool; and [HES] has presented evidence of the alleged copying of its FAS DRILL® tools by the Defendants." (A19.) The district court nonetheless concluded that the factual determinations under *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966), "overcome the secondary considerations." (A19.)

On reconsideration, the district court held that this Court's decision in *Amgen, Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313 (Fed. Cir. 2003), did not purport to change the law pertaining to the presumption of enablement for prior art references and, consequently, that there was no intervening change in the law to warrant reconsideration of HES's motion. (A21-22.) It therefore refused to admit into the record HES's '266 Fisher patent model (A25 at n.2) used at the hearing, or to consider the declarations filed by the parties.

III. SUMMARY OF THE ARGUMENT

The district court erroneously denied HES a preliminary injunction, giving the asserted claims impermissibly broad constructions that read on the prior art. When the asserted claims are construed according to the controlling law, they are both valid and infringed.

The district court failed to correctly construe the recited "slip means" of the asserted apparatus claims in accordance with 35 U.S.C. § 112, ¶ 6, even though each patent specification expressly defines "slip means" as including the combination of a slip wedge, slips, and a slip support, as disclosed and illustrated in the patents, and links such structures to the function recited in the claims. None of the "anticipatory" Fisher or Baker references disclose a tool with the claimed "slip means."

The district court similarly gave an improperly broad construction to the "packing means" of claim 3 of the '540 patent by failing to construe it in accordance with section 112, ¶ 6. The court further compounded its error by effectively erasing from the claims the limitation that the "slip means" and "packing means" each be "disposed on" the tool's mandrel.

The district court additionally failed to properly construe the limitation of claim 1 that the tool be positioned in "locking, sealing engagement" with the well bore. The court read the term "locking" to broadly cover the retrievable Baker tool that temporarily is positioned, but not locked, in a well bore. By its construction, the court removed from the claim the requirement, added during prosecution, that the drillable tool be placed in both locking and sealing engagement with the well bore, such that it could isolate well zones and yet not be forced out of the well bore with pressure from above or below. The court also broadly read the term "sealing" to cover the Fisher tool with its separated segments, which necessarily leak when expanded outwardly during the setting process.

When the claims are construed correctly, none of the references relied upon by the district court anticipate the asserted claims. In addition, none of the references, taken alone or in permissible combination, teach or suggest the claimed inventions as properly construed. Moreover, the district court committed reversible error when it declined to consider HES's objective evidence concerning

the nonobviousness of its patent claims *at the same time* it was analyzing the other *Graham* factors. Under a correct claim construction, the record as a whole persuasively demonstrates that as a matter of law the claimed combination was far from obvious.

As a result, the district court's opinion contains no valid basis to deny HES a preliminary injunction. Weatherford elected not to raise a substantial question concerning infringement, while BJ's infringement defense turns on legal constructs of the claims that are simply wrong. As no material facts are in substantial dispute regarding infringement, irreparable harm, and the public interest, this Court should direct the district court to enter the requested preliminary injunction order.

IV. ARGUMENT

A. Standard of Review

The Federal Circuit reviews a district court's decision denying a preliminary injunction "for an abuse of discretion, a lapse that occurs when the decision is premised on an error of law, a clearly erroneous finding of fact, or a clear error of judgment in weighing the factors. . . . To the extent the court's decision depends upon an issue of law, we review that issue *de novo*." *Oakley, Inc. v. Sunglass Hut Int'l*, 316 F.3d 1331, 1339 (Fed. Cir. 2003)(citations omitted).

B. The District Court Erred in Its Construction of the Claims

1. The Law of Claim Construction

In *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 981 (Fed. Cir. 1995) (en banc), *aff'd*, 517 U.S. 370 (1996), this Court reaffirmed that claim construction "is still based upon the patent and prosecution history." Claim terms are generally given their ordinary and accustomed meaning unless the patent and the prosecution history expressly indicate that the inventor used the terms differently. *Brookhill-Wilk 1, L.L.C. v. Intuitive Surgical, Inc.*, 334 F.3d 1294, 1298-99 (Fed. Cir. 2003). "The written description must be examined in every case, because it is relevant not only to aid in claim construction analysis, but also to determine if the presumption of ordinary and customary meaning is rebutted." *Id.* at 1298.

Moreover, the prosecution history is the "'undisputed public record' of proceedings in the Patent and Trademark Office [and] is of primary significance in understanding the claims." *Markman*, 52 F.3d at 980. Thus, this Court has "broad power to look as a matter of law to the prosecution history of the patent in order to ascertain the true meaning of language used in the patent claims." *Id.*

Claim construction is a question of law reviewed by the Court *de novo*. *Kemco Sales, Inc. v. Control Papers Co.*, 208 F.3d 1352, 1359-60 (Fed. Cir. 2000).

This proposition applies with equal force to the interpretation of the scope and meaning of a means-plus-function limitation. *Id.* at 1360.

2. "Slip Means Disposed on said Mandrel for Grippingly Engaging said Well Bore When in a Set Position"

Under 35 U.S.C. § 112, ¶ 6, "means plus function" elements are construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. *See Mas-Hamilton Group v. La Gard, Inc.*, 156 F.3d 1206, 1211 (Fed. Cir. 1998). Moreover, this Court has held that the "[u]se of the term 'means' in a claim limitation creates a presumption that section 112, paragraph 6 has been invoked," a presumption that can be rebutted only if the *claim limitation* "recites sufficiently definite structure to perform the claimed function." *Kemco Sales,* 208 F.3d at 1361.

The first step in the analysis is the identification of claimed function. *Micro Chem., Inc. v. Great Plains Chem. Co.*, 194 F.3d 1250, 1258 (Fed. Cir. 1999). In this case, the claimed "slip means" function in the apparatus claims is for "grippingly engaging said well bore when in a set position." Neither claim element recites sufficient structure to perform the claimed function. There is no evidence in the record that "slip means" has any defined meaning in the art, and the use of the word "slip" alone to modify "means" does not deprive the claim of means-plus-function status. *See Unidynamics Corp. v. Automatic Prods. Int'l*, 157 F.3d 1311, 1320-22 (Fed. Cir. 1998) ("spring means" held a means-plus-function

limitation even though a "spring" was an element of the structure disclosed in the specification).

The second step in the analysis is to look to the specification and identify the corresponding structure for that function. *Id.* Structure in the specification is considered corresponding structure only if the patent specification or prosecution history clearly links or associates such structure to the function recited in the claim. *Northrop Grumman Corp. v. Intel Corp.*, 325 F.3d 1346, 1352 (Fed. Cir. 2003).

In the present case, such linkage is clearly established. Each patent expressly *defines* the "slip means" in its specification. In the '468 patent, the recited slip means "for grippingly engaging the well bore when in a set position" is "a wedge engaging a plurality of slips with a slip support on the opposite side of the slips from the wedge." (A57, 3:19-21, 26-28.) In the '540 patent, the recited slip means with the claimed function is "a slip wedge positioned around the center mandrel, a plurality of slips disposed in an initial position around the mandrel and adjacent to the wedge, retaining means for holding the slips in the initial position, and a slip support on an opposite side of the slips from the wedge." (A75, 3:23-25, 29-34.) The disclosed "retaining means" is either a retaining band around the slips, a fracturable ring portion integrally formed with the slips, or shear pins. *See, e.g.*, A77, 8:16-23.

Appellees did not offer a contrary interpretation of "slip means" below in their opposition papers. (A9.) Nonetheless, the district court refused to construe "slip means" as necessarily including slip wedges or slip supports. Its decision was premised on a misunderstanding of language found *In re Lundberg*, 244 F.2d 543, 548 (CCPA 1957), to the effect that limitations in the patent specification not set forth in the claim itself could not be relied upon to impart patentability or satisfy the definiteness requirement of 35 U.S.C. § 112, ¶ 2. What the district court failed to appreciate is that, by virtue of section 112, paragraph 6, certain limitations in the patent specifications are deemed by law to be incorporated into the body of the claim. So long as the specification discloses at least one embodiment with corresponding structure to perform the recited function, the claim will be held definite. *Creo Prods., Inc. v. Presstek, Inc.*, 305 F.3d 1337, 1346 (Fed. Cir. 2002).

Claim 3 of the '540 patent recites that the claimed apparatus includes both "upper slip means" and "lower slip means" and, further, adds the requirement that the lower slip means be at least partially made of a non-metallic material. The only upper slip means and lower slip means "for grippingly engaging said well bore in a set position" described and disclosed in the '540 patent are the upper and lower slip assemblies comprised of slips, wedges, retaining means, and slip

supports disposed, respectively, above and below the packing means on the center mandrel.[8]

3. "Packing Means Disposed on said Mandrel for Sealingly Engaging said Well Bore When in a Set Position"

The "packing means" element of claim 3 of the '540 patent is also presumptively a means-plus-function element. The claimed packing means function in this claim is for "sealingly engaging said well bore when in a set position." This claim element, however, does not itself recite sufficient structure for performing this function. There is no evidence in the record that "packing means" has any defined meaning in the art, and the use of the word "packing" alone to modify "means" does not deprive the claim of means-plus-function status. *Unidynamics Corp.*, 157 F.3d at 1320-22.

The packing means disclosed in the '540 patent specification includes two end packer elements 40 and central packer element 42, each on the mandrel. (*See, e.g.*, A76, 5:63-64.) The patent explains that "packer elements 40 and 42 are in sealing engagement with the well bore" when the tool is "in a set position." (A80,

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[8] Should this Court hold that "slip means" is not a means-plus-function element, the result would not change. Any argument that "slip means" meant only slips is rebutted by the fact that the term "slip means" was expressly defined in the patent specifications (and, indeed, defined slightly differently in each patent.) HES's inventors were their own lexicographers, and were entitled to define "slip means" in such a fashion. *Brookhill-Wilk 1*, 334 F.3d at 1298-99.

14:61-68.) It further discloses that the upper and lower slip wedges apply squeezing force to the end and central packing elements so that they are axially compressed and radially expanded in the set position.

4. "Disposed On"[9]

The asserted apparatus claims require that the recited "slip means" be "disposed on" the center mandrel, and claim 3 of the '540 patent further requires that the recited "packing means" be "disposed on" the center mandrel. The plain meaning of "disposed on" clearly dictates physical contact between the slip means or packing means and the center mandrel, or the word "on" would be effectively written out of the claims. While the district court relied upon a dictionary definition of "disposed" to mean "placed or arranged" (A14), it failed to consider the ordinary, dictionary definition of "on" as meaning "to indicate position in or in contact with an outer surface." *See, e.g.*, Webster's Ninth New Collegiate Dictionary (1985)(second definition). Thus, its conclusion that "disposed on" does "not require that the slip means be physically attached to the mandrel" was erroneous. (A14.)

[9] To simplify issues, HES is not pursuing on appeal its interpretation of "disposed around" in method claim 1. HES nonetheless reserves the right to revisit this issue in a Markman proceeding before trial since the district court failed to appreciate that the word "around" has multiple meanings.

The specification, prosecution history, and 35 U.S.C. § 112, ¶ 6, all support this conclusion. Every embodiment in the HES patents discloses slip means and packing means in physical contact with the center mandrel. All corresponding structure, in a section 112, sixth paragraph sense, is structure that is physically in contact with the mandrel. Indeed, the reason the packing means is disposed on the mandrel is so that it can seal against the mandrel and the well bore, thereby placing the tool in sealing engagement.

Even if the ordinary meaning of "on" can be viewed as open to multiple interpretations, the only correct interpretation in view of the intrinsic evidence is that physical contact is required, as there is no teaching or suggestion of any embodiment where the slip means or packing means are not in contact with the center mandrel. Moreover, during prosecution, HES expressly relied on the "disposed on" language to distinguish its packer "disposed on the mandrel" from Sukup's packers 90 and 222 that were not in direct physical contact with mandrel 22 but instead disposed on nearby *sleeves* 94 and 184 that, in turn, were in contact with mandrel 22. (A1523; A1607 (Fig. 1); A1613, 4:46-51; A1614, 5:23-34.) The district court's failure to consider and appreciate the significance of the prosecution history was clear error. *See Lemelson v. TRW, Inc.*, 760 F.2d 1254, 1259-60 (Fed. Cir. 1985) (vacating grant of summary judgment on the district court's failure to understand the significance of the prosecution history). Thus, the construction

HES advocates is entirely consistent with the construction it proposed during patent prosecution.

5. "Positioning said Downhole Tool into Locking, Sealing Engagement with said Well Bore"

The district court made no serious attempt to analyze the language of the positioning step of claim 1 of the '468 patent. The term "positioning" in the phrase "positioning said downhole tool into locking, sealing engagement with said well bore" cannot be viewed in a vacuum, for the claim does not merely recite the step of positioning a downhole tool in a well bore. *See K Mart Corp. v. Cartier, Inc.*, 486 U.S. 281, 319 (1988) ("Words, like syllables, acquire meaning not in isolation but within their context."). To merely equate the claimed phrase, amended to distinguish over the prior art, with generically positioning a tool within a well bore, as the district court effectively did, erases meaningful limitations from the claim.

Indeed, the "locking, sealing engagement with said well bore" language must be read in context with other language in the claim that requires the steps of constructing a downhole tool having a plurality of slips for "grippingly engaging a well bore when in a set position" and drilling out the locked tool. Thus, it is not sufficient that the constructed tool be set in contact with the well bore, it must necessarily be a drillable tool in "locking, sealing engagement" with the well bore. Indeed, since the claim employs different phrases ("locking . . . engagement" and "grippingly engaging"), it is apparent that "locking . . . engagement" should not be

merely equated with slip engagement with the well bore. *Exxon Chem. Patents, Inc. v. Lubrizol Corp.*, 64 F.3d 1553, 1557 (Fed. Cir. 1995)(presumed that different meaning was intended when different words are used in a claim). It is entirely possible to have a tool's slips grip the well bore, and yet not be locked (as seen with the Baker devices).

Further light is shed on this claimed step by the patent's prosecution history. Once again, the district court's failure to consider the import of the prosecution history was clear error. *See Lemelson*, 760 F.2d at 1259-60. As discussed above, this limitation was expressly added to the claim in order to distinguish over other prior art tools that were merely positioned in the well bore but did not "lockingly engage the well bore at all" and did not "sealingly engage the well bore in the same sense as the present invention." (A1343-44.) This confirms that the claimed tool's ability to seal and lock the well bore is a critical aspect of the claimed invention. Mere slip engagement with the well bore wall alone is not sufficient.

The '468 patent disclosure is entirely consistent with a claim interpretation that requires the tool in the positioning step to not only grippingly engage the well bore, but additionally to provide locking and sealing engagement. All embodiments disclosed in the '468 patent achieve "locking, sealing engagement," not solely with the use of slips that engage the well bore at some point, but through the application of opposing axial forces imparted by the slip assemblies above and

below the packing element and by the packing element. Once the tool is locked in position, it is fixed in place and can only be removed by drilling it out, as required by claim 1.

This construction of locked engagement is wholly consistent with the skilled artisans' understanding of a drillable tool "locked" in a well. Sukup, for example, disclosing a different drillable tool permanently locked in the well, expressly explains that "once the tool is set in place, release is not possible by mechanical release features." (A1615, 7:17-19.) Harris gave a similar definition. (A1100-01.)

Similarly, "sealing engagement" cannot be equated with leaking engagement. The ordinary meaning of the noun "seal" is "a tight and perfect closure (as against the passage of gas or water)." Webster's Ninth New Collegiate Dictionary (1985)(definitions 1c(1); emphasis added). The ordinary meaning of the verb "seal" in the context of the patent is "to close or make secure against access, leakage, or passage by a fastening or coating." Webster's Ninth New Collegiate Dictionary (1985) (definition 3b; emphasis added). These ordinary meanings are consistent with the use of the word "seal" and its derivatives throughout the specification. These ordinary meanings are also consistent with the disclosed inventions which even the district court recognized included a packing element on the mandrel "to seal off the lower portion of the well bore." (A3.)

The district court nonetheless construed claim 1 to require only some undefined degree of incomplete sealing. It concluded that claim 1 does "not require that the bridging plug perfectly seal the well bore." (A13.) The district court's unfounded claim construction was obviously result-oriented, based on an implicit recognition that Fisher had axial leak paths and would not anticipate claim 1 if HES's interpretation of "sealing engagement" were adopted.

C. The District Court Erred in Finding a Substantial Question Regarding the Novelty of the Claimed Inventions

If HES's construction of the claims is correct, then the district court's conclusion as to anticipation cannot stand. To anticipate, each and every limitation of the reference must be found in a single prior art reference, and the reference must also enable one of skill in the art to make and use the claimed invention. *Transclean Corp. v. Bridgewood Services, Inc.*, 290 F.3d 1364, 1370 (Fed. Cir. 2002).

The Fisher and the Baker references, however, fail to disclose the following:

(1) a "***slip means***" that include ***all*** three slip assembly components (slip wedges, slips, and slip supports) required by claim 30 of the '468 patent and ***all*** four slip assembly components (the above three plus a retaining means) required by claim 3 of the '540 patent. Appellees' argument that Fisher's wooden conical "bore" is a slip wedge fails because the bore is located on the interior surfaces of segments 10 contiguous with mandrel 14 and cannot engage the metallic slips

found on the exterior side of segments 10. The Fisher and the Baker references also lack slip supports on the opposite side of the slips from the wedges.

(2) ***dual*** "***slip means***" required by claim 3 of the '540 patent. Fisher discloses upper and lower slips, but it lacks the claimed wedges and slip supports, as noted above.

(3) the step of positioning the tool "***into locking, sealing engagement***" with a well bore as required by claim 1 of the '468 patent. Properly construed as above, this claim requires the tool to remain in both locked and sealing engagement with the well bore such that it must be later drilled out (another material additional step of claim 1). The Baker retrievable tools may be set in a well bore, but they are never locked and sealed in place in the manner required by the claims, and are removed without drilling. Indeed, the Baker tools with a single slip assembly on one side of a packer element are expressly made to *release* from the well when a downward axial force is applied to the tool. This is the antithesis of HES's claimed locking step, and precisely the sort of construct over which the claims were amended to distinguish.

While Fisher's tool at least in theory is designed to be left in the well in an expanded position, the disclosed and illustrated tool inherently cannot, when expanded outward to this position, be in "sealing engagement" with the well bore. Fisher expressly discloses that the segments 10 *separate* as the tool is expanded.

(A1205, lns. 64-68.) Indeed, even without resort to any demonstrative models, basic rules of physics dictate that the segments 10 cannot change in shape or size and must expand outwardly and therefore separate from each other, as the tool is pulled to the expanded position, permitting axial flow through the plug. While the packing rings 22 arguably seal the outer portions of the segments 10, against which the rings rest, with the respective immediately opposite portions of the well bore, such interaction does not position the downhole tool in sealing engagement with the well bore. The gaps *between* the segments remain open and unsealed, with the inevitable result that the Fisher tool cannot be positioned to be in both locking and sealing engagement with the well bore as required by method claim 1. Once again, there is no way for the disclosed rubber bands to expand radially inward to fill the resultant gaps between the separated segments without violating the laws of physics. No other sealing means in Fisher is detailed.

In addition, Fisher fails to disclose:

(4) a "***slip means*** ***disposed on***" the mandrel, as required by the apparatus claims. Fisher does not anticipate these claims because its slips are disposed on segments 10 and not on the center mandrel.

(5) a "***packing means*** ***disposed on***" the mandrel, as required by claim 3 of the '540 patent. Fisher does not anticipate this claim because its rubber rings on segments 10 are not the same or equivalent to the corresponding structure

disclosed in the '540 patent and in any event are not disposed on the center mandrel.

The Baker references also fail to disclose:

(6) the step of "*drilling said tool out of the well bore*," as required by claim 1 of the '468 patent. The Baker references do not anticipate the invention of claim 1 because they do not disclose drilling the Baker retrievable tools out of the well bore. (A16.)

D. The District Court Erred in Finding a Substantial Question Regarding the Obviousness of the Claimed Inventions

1. The District Court Failed to Properly Consider Objective Evidence of Nonobviousness in Its Analysis

This Court's precedent clearly establishes that a district court must consider objective indicia of nonobviousness along with whatever evidence is alleged to establish the obviousness of a claimed invention before determining whether a claimed invention would or would not have been obvious. Considering such evidence after the fact constitutes reversible error.

In *Lindeman Maschinenfabrick GMBH v. American Hoist and Derrick Co.*, 730 F.2d 1452, 1461 (Fed. Cir. 1984), for example, this Court explained:

> The district court correctly stated that commercial success cannot by itself establish nonobviousness. However, having concluded that the claimed invention would have been obvious from the prior art, the court looked only to see whether the showing of commercial success was so overwhelming as to overcome that conclusion. That was error.

> All evidence must be considered before a conclusion on obviousness is reached.

[Emphasis in original.] *See also In re Piasecki*, 745 F.2d 1468, 1474 (Fed. Cir. 1984)

Page after page of the district court's opinion reveals that it stated, on no less than six occasions, that the Baker and/or the other references raised a substantial question about the obviousness of HES's patent claims or that they rendered such claims obvious *before* the court cursorily addressed HES's evidence on this issue. (A15-18.) This was particularly prejudicial to HES because, as the district court admitted, such evidence on its own "favor[ed] a finding of nonobviousness of HES's patents-in-suit." (A19.) Nonetheless, it erroneously viewed such compelling evidence as being "secondary" and "overcome" by the other *Graham* determinations. (A19.)

2. The Record Taken as a Whole Establishes that The Cited Prior Art Fails To Teach or Suggest The Inventions Claimed in HES's Patents

It is, of course, well-established that objective indicia of nonobviousness such as commercial success, long-felt need, failure of others, teaching away, industry skepticism, peer recognition, and copying can support a nonobviousness

conclusion.[10] But as persuasive as the record is on these issues, it is the consideration of these factors in connection with the teachings of the prior art and the development of the claimed invention that paints the true picture of the nonobviousness of the claimed inventions.

The Fisher patent dates all the way back to 1928 and there is no evidence that it was ever commercialized. It fails to teach or suggest the slip means structure of the apparatus claims, or to dispose its slip assembly and rubber rings on the center mandrel as required by the apparatus claims. Fisher, by its express disclosure and teachings, creates axial gaps between the separated segments 10 when the tool is expanded in a well and fails to disclose any scientifically plausible way to plug those gaps so as to achieve "locking, sealing engagement" with the well bore, as required by claim 1.

The Baker references are over thirty-five years old and deal with *retrievable* tools known to be unreliable and expensive to use. (A666, 1:28-30.) One looking for improved solutions to the drillable tool art would not be motivated to modify

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[10] *See, e.g., Modine Mfg. Co. v. United States Int'l Trade Comm'n*, 75 F.3d 1545, 1556 (Fed. Cir. 1996)(commercial success, long felt need, teaching away); *Applied Materials Inc. v. Advanced Semiconductor Materials Am., Inc.*, 98 F.3d 1563, 1570 (Fed. Cir. 1996)(failure of others); *Vulcan Eng'g Co. v. Fata Aluminum, Inc.*, 278 F.3d 1366, 1373 (Fed. Cir.)(skepticism, peer recognition), *cert. denied*, 537 U.S. 814 (2002); *Specialty Composites v. Cabot Corp.*, 845 F.2d 981, 991 (Fed. Cir. 1988)(copying).

the Baker retrievable tools that do not require drill out and that set in an entirely different way. Indeed, the lack of motivation to work with the Baker design in a drillable tool context is ably evidenced by the testimony of Mr. Harris, who didn't consider the Baker design to be of any use in Western's development of a drillable tool with non-metallic parts, and accordingly did not cite it to the PTO as being relevant to the invention claimed in the Sukup patent. (A1133-36.)

The Baker references fail to teach or suggest the claimed slip means structure. Like the Watson patent cited by the examiner during prosecution and specifically distinguished by amendment, Baker tools are not permanently set into the claimed "locking, sealing engagement" with the well bore. The Baker references are also cumulative to Armentrout and other patents cited but not applied during prosecution that also disclosed non-locking well tools with non-metallic mandrels. (A1323-24, A1328, A1335; A1538-46.)

The Muse patent adds nothing over the art considered before the patents were granted. Among its differences with the claimed invention is the fact that it does not teach or suggest that either the center mandrel or its slips should be non-metallic for easy drill out. As such, it is no more relevant than the Sullaway patent cited but not applied by the examiner during patent prosecution. (A1504-05, A1509, A1515; A1591-1600.)

Despite a clear economic motivation in the industry to avoid extended drilling time, no one prior to HES's invention was able to successfully develop drillable tools with non-metallic mandrels or slip means that could be positioned in locking, sealing engagement with a well bore. Despite the considerable effort by Sukup and Harris some twenty years after Baker, their attempts to develop a workable tool with non-metallic mandrels and slip components failed completely and their work was abandoned. (A1117-28.) Moreover, the tools they ultimately devised and patented had problems and were never commercialized. (A1131; A1137-39; A1146-47.)

As disclosed in the Sukup patent, Sukup and Harris continued to advocate the use of metallic, rather than non-metallic, materials for the high stressed mandrel and slip components that are at the heart of HES's claimed invention. They also advocated a single slip assembly design. Indeed, less than four years before the filing date of the parent application to the '468 patent, Sukup expressly taught away from any solution utilizing a dual slip assembly, the very assemblies used in each of HES's disclosed embodiments. (A1612, 1:65 - 2:27.)

The Sukup and Harris work is also probative of nonobviousness for yet another reason. The Western Company was the predecessor of BJ. As noted by this Court in *Heidelberger Druckmaschinen v. Hantscho Commercial Products, Inc.*, 21 F.3d 1068, 1072 (Fed. Cir. 1994), a "[l]itigation argument that an

innovation is really quite ordinary carries diminished weight when offered by those who had tried and failed to solve the same problem, and then promptly adopted the solution that they are now denigrating."

For decades after Fisher, the art had headed away from the use of *non-metallic* mandrels and slips in *drillable* tools, a situation that continued right up to the development of the HES patents. The Baker and Sukup references expressly taught away from the use of dual slip assemblies. *See Winner Int'l Royalty Corp. v. Wang*, 202 F.3d 1340, 1350 (Fed. Cir. 2000) (one of ordinary skill in the art would not be motivated to combine a reference that taught away from the claimed invention with other references). Such teaching away also creates a strong inference that the references do not provide a reasonable expectation of a chance of success to render the invention obvious. *Life Techs., Inc. v. Clontech Labs., Inc.*, 224 F.3d 1320, 1326 (Fed. Cir. 2000). Yet, it was precisely the use of such a dual slip means in combination with the claimed packing means that was able to achieve a drillable tool that could be permanently set in the claimed locking, sealing engagement with the well bore. The use of non-metallic mandrels or slip means in this configuration solved the long felt need for easier, cheaper, drill out.

Taken together, the references fail to teach or suggest the claimed inventions. As stated by this Court in *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1334 (Fed. Cir. 2002), "[t]he showing of a motivation to combine must

be clear and particular, and it must be supported by actual evidence." Moreover, for the combination to render a claim obvious, one of ordinary skill in the art at the time must have had a reasonable expectation of success in applying the teachings of the references. *Yamanouchi Pharm. Co. v. Merck & Co.*, 231 F.3d 1339, 1344-45 (Fed. Cir. 2000). No such showing was made by the Appellees or identified by the court below. In that regard, "[T]here can be little better evidence negating an expectation of success than actual reports of failure," *Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp.*, 320 F.3d 1339, 1354 (Fed. Cir. 2003), which applies with equal force to the failures by Baker and Messrs. Sukup and Harris.

In summary, it is apparent that the district court engaged in hindsight reconstruction of the art, using the HES patent claims as a roadmap to pick and choose the individual elements or steps out of the prior art. *See Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1143 (Fed. Cir. 1985)(improper for district court to select from the prior art the separate components of the inventor's combination using the "blueprint" supplied by the inventor of the patent). The court compounded this error by construing the claims too broadly and failing to consider the compelling evidence of nonobviousness, before determining the obviousness question. The actual disclosures and teachings of the prior art, combined with HES's other evidence of record, such as of commercial success and

significant cost savings, lead to the unmistakable conclusion that the district court erred in concluding that a substantial question existed regarding the obviousness of the claimed inventions.

E. The Court Should Direct the District Court to Enter an Order Preliminarily Enjoining the Appellees

The only basis given by the district court to support denial of a preliminary injunction was the erroneous conclusion that a substantial question as to validity had been raised. As no other legal basis is present in this record, this Court should direct the district court to enter a preliminary injunction on remand.

1. HES has Made a Strong Showing of a Likelihood of Success in Proving Infringement

As discussed in Section II.C.4. above, Weatherford raised no substantial question as to noninfringement.

As to claim 3 of the '540 patent, BJ's noninfringement argument (use of metallic slips in its current Python tool) was based solely upon a legally erroneous construction of the claimed "slip means." While certain nonasserted claims (e.g., claim 30 in the '540 patent) require the recited "slips" to be non-metallic, claim 3 on its face only requires that a *portion* of the claimed lower slip means be "at least partially made of a non-metallic material." Since the lower slip means includes a slip wedge, a slip support, and a retaining means as well as slips, this claim *permits* but does not *require* that *slip* portions of the lower slip means assembly be non-

metallic. As a result, the presence of non-metallic cones and slip supports in Python's slip means assembly is sufficient to infringe this claim.

Insofar as BJ's infringement of claims 1 and 30 of the '468 patent is concerned, there is no factual dispute between the parties. BJ has merely inserted a brass tube inside its original Python non-metallic mandrel design, not unlike the tension sleeve 62 that HES disclosed as being within its non-metallic mandrel. BJ's own witness has recognized that this brass tube is a component in addition to the mandrel itself. (A764 at ¶ 15.) As such, it is no more a part of the mandrel than the separate metallic tension sleeve 62 disclosed in the HES patents. The addition of such an element cannot as a matter of law avoid infringement of these claims. *See Tate Access Floors, Inc. v. Maxcess Technologies, Inc.*, 222 F.3d 958, 970 (Fed. Cir. 2000).

2. HES's Presumption of Irreparable Harm

The Court has long applied a presumption of irreparable harm when the patentee has made a strong showing of likelihood of success on the merits coupled with continuous infringement. *Smith, Int'l, Inc. v. Hughes Tool Co.*, 718 F.2d 1573, 1580-81 (Fed. Cir. 1983). HES is therefore entitled to a presumption of irreparable harm on this record.

In fact, the evidence summarized in Section II.C.5. above concerning HES's loss of market share, eroded prices, loss of customer goodwill, and employee

layoffs ably demonstrates that money damages alone will never fully compensate HES for the effects of Appellees' infringement. *Purdue Pharma L.P. v. Boehringer Ingelheim GmbH*, 237 F.3d 1359, 1367-68 (Fed. Cir. 2001). The finite term of HES's patents also contributes to the issue of irreparable harm. *H.H. Robertson Co. v. United Steel Deck, Inc.*, 820 F.2d 384, 390 (Fed. Cir. 1987), *overruled on other grounds*, *Markman*, 52 F.3d 967. Less than half of the life of the HES patents remain, and several more years will elapse before trial commences and a final decision on appeal is obtained. The interest of justice warrants imposing a preliminary injunction at this time to protect HES from further irreparable harm.

3. The Balance of Hardships Lies in HES's Favor

As recognized in *Bell & Howell Document Mgmt. Prods. Co. v. Altek Sys.*, 132 F.3d 701, 708 (Fed. Cir. 1997), the hardship to an infringer cannot insulate it from the issuance of a preliminary injunction if the other three preliminary injunction factors are sufficient to tip the scale in the patentee's favor. In this case, Appellees have already enjoyed over two years of uninterrupted ability to market their infringing products and services. An injunction at this time for the duration of the district court litigation would no more injure Appellees than HES has already been injured. Moreover, the Appellees have other products (such as cast iron drillable well tools) that they sell so that they will not be put out of business

by such an injunction. (A597 at ¶ 16; A598 at ¶ 19.) In addition, Appellees' actions in deliberately copying HES's patented FAS DRILL® tool design further tip the balance of hardships in HES's favor. *See, e.g., Saes Getters, S.p.A. v. Ergenics, Inc.*, 816 F. Supp. 979, 987 (D.N.J. 1992), *aff'd without opinion*, 989 F.2d 1201 (Fed. Cir. 1993).

4. The Public Interest Supports the Grant of a Preliminary Injunction Order

A "strong public policy" favors enforcing patent rights. *PPG Industries, Inc. v. Guardian Industries, Corp.*, 75 F.3d 1558, 1567 (Fed. Cir. 1996). The public interest will not be adversely affected by the grant of a preliminary injunction in this case. If Appellees are enjoined, the public will have the choice of buying either unpatented drillable tools from the Appellees and others, or buying the patented drillable tools from HES, as they did before Appellees unlawfully entered the marketplace.

V. CONCLUSION

For the foregoing reasons, HES respectfully requests that this Court adopt HES's claim constructions, vacate the district court's validity findings, and direct the district court to enter a preliminary injunction. At a minimum, the Court

should remand the case for a new decision in light of the Court's interpretation of the claims on appeal.[11]

Respectfully submitted,

December 15, 2003

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[11] If the appeal is remanded to the district court for redetermination, the district court should be directed to consider all evidence bearing on the enablement of the prior art.

ADDENDUM

ORIGINAL

U.S. DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
FILED
- 4
CLERK, U.S. DISTRICT COURT
By ______
Deputy

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

HALLIBURTON ENERGY SERVICES, INC.	§	
	§	
Plaintiff,	§	
	§	
v.	§	Civil Action No. 3:02-CV-1347-N
	§	
WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY	§	
	§	
Defendants,	§	

MEMORANDUM OPINION AND ORDER

Plaintiff Halliburton Energy Services, Inc. ("Halliburton") complains against Defendant Weatherford International, Inc. ("Weatherford") and Defendant BJ Services Company ("BJ") for patent infringement under 35 U.S.C. §§ 1, *et seq*. Halliburton seeks judgment against the Defendants and injunctive relief against further infringement of the claims of United States Patent Number 5,271,468 (the " '468 patent"), issued December 21, 1993 and United States Patent Number 5,224,540 (the " '540 patent"), issued July 6, 1993, each entitled "Downhole Tool Apparatus with Non-Metallic Components and Methods of Drilling Thereof."

Before the Court is Halliburton's motion for a preliminary injunction. Oral arguments were held on Halliburton's motion on September 19, 2002. After considering the Parties' briefs and arguments, and for the reasons stated below, this motion is DENIED.

I. Background

Halliburton, Weatherford, and BJ all provide services and equipment to customers in the oil industry. Halliburton's patents at issue in this action relate to oil well tools called bridge plugs, see Figure 1 from the '468 patent at right. Bridge plugs are used to seal off or "plug" portions of an oil well during certain oil production procedures. Often times after the procedures are complete, bridge plugs are removed from the oil wells. The claims at issue for the purpose of deciding this motion pertain to the bridge plug apparatus itself and a method of setting the bridge plug in a well bore[1] and then removing the plug by drilling it out. Figure 1 illustrates a bridge plug set in place in a well casing about to be drilled out and removed from the well.

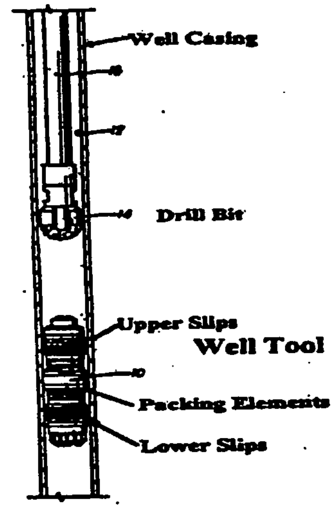

FIG. 1
5,271,468

Traditionally, bride plugs were constructed of metals such as steel or cast-iron. The relevant claims of Halliburton's '468 and '540 patents pertain to bridge plugs made of non-metallic component parts. The relevant component parts of a bridge plug include (1) a center mandrel – the main structural body on which the tool is built, (2) a packing element – an

---

[1]A well bore is a hole made by a drilling rig. Oil and gas wells are drilled into the earth using large drilling rigs capable of lifting and rotating long, heavy strings of drill pipe with a drill bit at the end. These wells can be very deep, penetrating thousands of feet into the earth. After the well is drilled, a string of relatively large-diameter tubing called casing is lowered into the well bore by the drilling rig and then cemented into place. For the purposes of this opinion, the well bore and the well casing are treated as the same structures.

often doughnut-shaped, rubber element positioned around the center mandrel to seal off the lower portion of the well bore, and (3) slips – anchoring assemblies to hold the tool in place. Figure 8 from the '468 patent, depicted on the right, demonstrates one embodiment of Halliburton's bridging plug. The anchoring components in figure 8 consist of upper and lower slips, slip supports, and wedges. When the well tool is set, the packer elements are compressed and expand to form a seal with the well casing (as shown). This expansion pushes the upper wedge upward and the lower wedge downward and the forces the slips outward to engage the well casing. In this embodiment of the Halliburton's invention, the slip supports help hold the slips, and therefore the bridge plug, in place in the well bore. Halliburton claims that its tool's non-metallic composition allows for a less expensive and more reliable removal of the plug from an oil well bore.

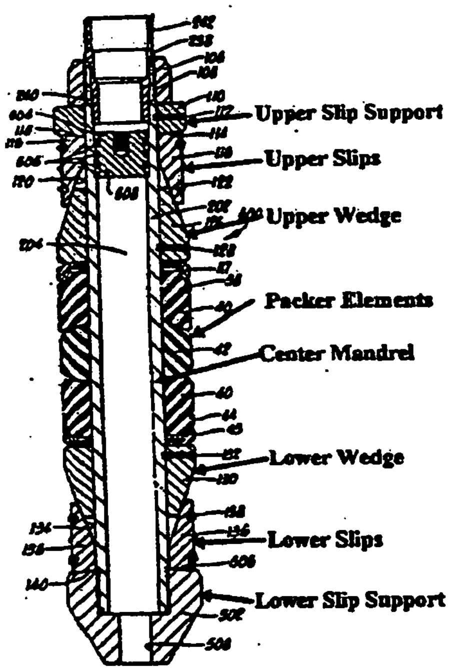

FIG. 8

5,271,468

Halliburton's non-metallic bridge plugs, marketed as part of their FAS DRILL® tool line, are removed by drilling the plugs out of the well bore. The plugs are drilled into small bits and chips that can be circulated through and flushed out of the well bore. Halliburton asserts that prior to its non-metallic tools, most drillable bridge plugs were constructed of cast-iron. These cast-iron plugs were more costly and problematic to drill out of well bores

than non-metallic plugs. Halliburton claims that its FAS DRILL® plugs can be removed from well bores with less expensive equipment, in less time, and with fewer problems than their metallic counterparts.

Halliburton contends in its motion that Weatherford and BJ are infringing upon claims 1 and 30 of its '468 patent and claim 3, which is dependent upon claim 2, which is dependent upon claim 1, of its '504 patent. These claims read as follows:

Claim 1 of the '468 Patent

1. A well bore process comprising the steps of:
constructing a downhole tool such that a component thereof is made of a non-metallic material, said tool comprising:
a center mandrel; and
a plurality of slips disposed around said mandrel for grippingly engaging a well bore when in a set position;
wherein at least one of said mandrel and said plurality of slips is said component;
positioning said downhole tool into locking, sealing engagement with said well bore; and
drilling said tool out of said well bore.

Claim 30 of the '468 Patent

30. A downhole apparatus for use in a well bore, said apparatus comprising:
a center mandrel made of non-metallic material; and
slip means disposed on said mandrel for grippingly engaging said well bore when in set position.

Claims 1-3 of the '540 Patent

1. A downhole apparatus for use in a well bore, said apparatus comprising:
a center mandrel; and
slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means being at least partially made of a non-metallic material.

> 2. The apparatus of claim 1 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.
>
> 3. The apparatus of claim 2 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means being at least partially made of a non-metallic material.

Halliburton argues that Weatherford's FracGuard Composite plugs and BJ's Python Composite plug incorporate aspects of its FAS DRILL® tools and infringe upon the cited patent claims. The Defendants' plugs, Halliburton asserts, have non-metallic center mandrels and slip assemblies made at least partially of non-metallic materials. Additionally, Halliburton claims that the Defendants' marketing materials boast quick and easy drill outs of their composite (non-metallic) plugs.

II. Discussion

To obtain a preliminary injunction, Halliburton must show "(1) a reasonable likelihood of success on the merits; (2) irreparable harm if an injunction is not granted; (3) a balance of hardships tipping in its favor; and (4) the injunction's favorable impact on the public interest." *Amazon.com, Inc. v. Barnesandnoble.com, Inc.*, 239 F.3d 1343, 1350 (Fed. Cir. 2001). With regard to the first element, Halliburton must show, in light of the burdens that will inhere at trial, that (1) its patent was infringed, and (2) any challenges to the validity and enforceability of its patent "lack substantial merit." *Purdue Pharma L.P. v. Boehringer Ingelheim GmbH*, 237 F.3d 1359, 1366 (Fed. Cir. 2001).

Weatherford and BJ challenge the validity of Halliburton's patents. Specifically, the Defendants claim that Halliburton's relevant patent claims were anticipated or rendered obvious by prior art. An assessment of the likelihood of validity of a patent claim over the prior art also involves a two-step process. First, the court determines the scope and meaning of the patent claims asserted to determine the subject matter for which patent protection is sought. *See Smiths Indus. Med. Sys., Inc. v. Vital Signs, Inc.*, 183 F.3d 1347, 1353 (Fed. Cir. 1999). Secondly, the properly construed claims are compared with the prior art. *Id.* at 1354. A determination that a claim is invalid as being anticipated or lacking novelty under 35 U.S.C. § 102 requires a finding that "each and every limitation is found either expressly or inherently in a single prior art reference." *Celeritas Techs. Inc. v. Rockwell Int'l Corp.*, 150 F.3d 1354, 1361 (Fed. Cir. 1998). Whether a claim would have been obvious within the meaning of 35 U.S.C. § 103 is a question of law based on underlying findings of fact including: "(1) the scope and content of the prior art, (2) the level of ordinary skill in the art, (3) the differences between the claimed invention and the prior art, and (4) secondary considerations of nonobviousness." *Smiths*, 183 F.3d at 1354 (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)).

Because an issued patent is presumed to be valid, 35 U.S.C. § 282, the Defendants must establish invalidity by clear and convincing evidence. *WMS Gaming Inc. v. Int'l Game Techs.*, 184 F.3d 1339, 1355 (Fed. Cir. 1999). In the context of a preliminary injunction, however, while "the burden of proving invalidity is with the party attacking validity," the party seeking the injunction "retains the burden of showing a reasonable likelihood that the

attack on its patent's validity would fail." *H.H. Robertson Co. v. United Steel Deck, Inc.*, 820 F.2d 384, 387 (Fed. Cir. 1987). When the presumptions and burdens applicable at trial are taken into account, the injunction should not issue if the party opposing the injunction raises "a substantial question concerning infringement or validity, meaning that it asserts a defense that [the party seeking the injunction] cannot prove lacks substantial merit." *Tate Access Floors v. Interface Architectural Resources, Inc.*, 279 F.3d 1357, 1365 (Fed. Cir. 2002) (internal quotation marks omitted); *New Eng. Braiding Co. v. A.W. Chesterton Co.*, 970 F.2d 878, 883 (Fed. Cir. 1992) ("While it is not the patentee's burden to prove validity, the patentee must show that the alleged infringer's defense lacks substantial merit.").

A. Anticipation by the '266 Patent

Both Defendants argue that Halliburton's patents are invalid because of anticipation. A patent is anticipated and therefore invalid when the invention was described in a printed publication either before the date of invention by the applicant or more than one year before the date of the application for the patent in the United States. 35 U.S.C. §§ 102(a), 102(b) (2003). For a claim to be invalid on the basis of anticipation under section 102(b), "[t]he invention must have been known to the art in the detail of the claim; that is, all of the elements and limitations of the claim must be shown in a single prior art reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001).

Weatherford argues in its surreply that United States Patent Number 1,684,266 (the " '266 patent"), entitled "Bridging Plug," issued on September 11, 1928 anticipates the

relevant claims of Halliburton's '468 and '540 patents. The '266 patent is for an improved bridge plug made of wood, a non-metallic material.[2] This patent raises a substantial question regarding the validity of Halliburton's relevant patent claims.

1. Claim 1 of the '468 Patent

Claim 1 of the '468 patent describes a process for (i) locking and (ii) sealing an oil well tool, i.e. bridge plug, in a well bore and then (iii) drilling the tool out of the hole. The '468 tool apparatus itself contains (iv) a center mandrel and (v) a plurality of slips (for positioning the tool in place) wherein (vi) either the mandrel or the slips are made of a non-metallic material. In comparison, the '266 patent discloses a bridging plug that has (iv) a center mandrel constructed of (vi) wood that can be easily (iii) drilled out of a well bore. App. at W00213, lines 16-21, 90-98. The '266 plug utilizes a (v) plurality of slips that (i) engage the well bore to prevent movement of the tool when the plug is set. App. at W000214, lines 3-12. The '266 bridging plug also has rubber rings distributed around the mandrel for (ii) sealingly engaging the well bore when the plug is locked in position. *Id.* at lines 68-73. The '266 patent, therefore, discloses the elements and limitations of Claim 1 of the '468 patent.

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[2]The Patent and Trademark Office ("PTO") did not review the '266 patent prior to its issuance of Halliburton's patents-in-suit. "Deference is due the PTO's decision to issue a patent with respect to evidence bearing on validity which it considered but no such deference is due with respect to evidence it did not consider." *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1359 (Fed. Cir.), *cert. denied*, 469 U.S. 821 (1984).

2. Claim 30 of the '468 Patent

The '266 patent likewise appears to anticipate Claim 30 of the '468 patent. Claim 30 describes the bridge plug apparatus as comprising (i) a non-metallic center mandrel and (ii) a slip means disposed on the mandrel for grippingly engaging the well bore when the tool is in a set position. As discussed above, the '266 patent discloses a bridging plug apparatus containing (i) a non-metallic (wood) center mandrel and a plurality of slips for locking, or grippingly engaging, the well bore when the tool is set. The apparatus of claim 30 however differs from claim 1 in that 30 requires the apparatus to contain a "slip means." Halliburton argues that "slip means," as defined in the specification of the patent-in suit, includes (a) slips, (b) a cone for wedging the slips, and (c) a support structure for the slips on the opposite side of the slips from the wedge. App. at 000010, col. 3, l. 26-28; App. at 000029, col. 29-34. The Defendants do not offer an alternate construction of slip means. In response to Halliburton's construction of "slip means," Weatherford argues that the '266 plug utilizes (a) slips and (b) a tapered, conical wooden component that wedges the slips into engagement with the well bore. Weatherford, however, does not directly address in its argument whether the '266 patent discloses the element of a slip support structure on the opposite side of the slips from the wedge.

A *Markman* hearing will ultimately determine the proper construction of the term "slip means," however, for the purposes of this motion, the "slip means" language is broad enough to apply to the slip structure disclosed in the '266 patent. When claims are drafted in "means plus function" form, the presumption is that 35 U.S.C. § 112 ¶ 6 applies. A "means plus

function" claim limitation is construed to cover the structure disclosed in the specification of the patent to perform the claimed function plus equivalents of that structure. *Caterpillar Inc. v. Deere & Co.*, 224 F.3d 1374, 1379 (Fed. Cir. 2000).

The means plus function limitation does not override, however, the section 112 requirement that the claims particularly point out and distinctly claim the subject matter of the invention. *In re Donaldson Co.*, 16 F.3d 1189, 1195 (Fed. Cir. 1994). A claim can not be limited by reading the specification into the claim:

> it is the language itself of the claims which must particularly point out and distinctly claim the subject matter which the applicant regards as his invention, without limitations imported from the specification, whether such language is couched in terms of means plus function or consists of a detailed recitation of the inventive matter. Limitations in the specification not included in the claim may not be relied upon to impart patentability to an otherwise unpatentable claim.

In re Lundberg, 244 F.2d 543, 548 (C.C.P.A. 1957).

Claim 30 of Halliburton's '468 patent requires a slip means disposed on the tool's mandrel for grippingly engaging the well bore when the tool is in a set position. The claims of the '266 patent disclose slips engageable upon the casing, designed to prevent upward and downward movement of the plug within the casing. Functionally, both slip structures engage the well bore or well casing to prevent movement of the plug when the tool is set. If the precise structure of the "slip means" was critical to establishing the novelty of Halliburton's invention, then it was incumbent upon Halliburton to particularly point out and distinctly claim that structure. Because Halliburton's patent claims do not include a support structure

for the slips on the opposite side of the slips from the wedge, the Court declines to read this limitation into claim 30 of the '468 patent in order to avoid the anticipation of the '468 patent by the '266 patent. A slip support on the opposite side of the slips from the wedge, therefore, is not a necessary element of "slip means." The '266 patent, thus, discloses the elements and limitations of claim 1 of the '468 patent.

3. Claims 1-3 of the '540 Patent

Claim 3 of the '540 patent, like claim 30 of the '468 patent, is an apparatus claim describing the bride plug. The elements of claim 3, which is dependent upon claim 2, which is dependent upon claim 1, include (i) a center mandrel, (ii) a packing means disposed on the mandrel for sealingly engaging the well bore when the tool is set, (iii) a partially non-metallic slip means, wherein the slip means consists of (a) an upper slip means disposed above the packing means, and (b) a lower slip means, being at least partially non-metallic, disposed below the packing means. The '266 patent discloses these elements and limitations and therefore anticipates claim 3 of the '540 patent.

As discussed previously, the bridging plug described in the '266 patent has a (i) center mandrel. The '266 tool also has (ii) a packing means – rubber rings and possibly wooden segments[3] disposed on the mandrel that sealingly engage the well bore when the tool is set. App. at W000214, lines 68-73 ("The rubber rings 22 also engage the casing and are compressed, thus forming a packer or seal to prevent the leakage of fluid between the

[3]The wooden segments of the '266 tool form a cylinder around the mandrel, and when the tool is set, the segments push on the slip cones to lock the slips in the well bore.

exterior surface of the segments 10 and the casing."). As discussed in construing the elements of claim 30, the '266 tool contains (iii) a slip means partially made of wood. Additionally, the slip means consists of (a) upper slips located above the rubber rings and (b) lower slips located below the rings. App. W000214, l. 3-12 ("These [upper] slips have upwardly directed teeth 18, which, when they engage the casing C, will prevent upward movement of the plug within the casing. Each of the segments 10 has a stationary slip 19 secured to its lower end, these slips being provided with downwardly directed teeth 20, which, when they engage the casing, will prevent downward movement of the plug.") The lower slip means also utilize the wooden conical element for wedging the slips, therefore the lower slip means are partially non-metallic. The '266 patent, therefore, discloses the elements and limitations of Claim 3 of the '540 patent, and claims 1 and 30 of the '468 patent.

4. Halliburton Has Not Shown that Weatherford's Anticipation Defense Lacks Substantial Merit

Weatherford has succeeded with its burden of raising a substantial question regarding the validity of the relevant claims of Halliburton's patents-in-suit. Halliburton, however, has failed to show that Weatherford's defense lacks substantial merit. In its response to Weatherford's surreply, Halliburton argues that the '266 tool (1) cannot seal the well bore, (2) does not have a plurality of slips disposed on the mandrel, and (3) has no seal member on the mandrel. The Plaintiff's arguments are unavailing.

First, the relevant claims of Halliburton's patents do not require that the bridging plug perfectly seal the well bore. Claim 1 of the '468 patent, rather, requires that the bridge plug is positioned into a locking, sealing engagement with the well bore, and claim 2 of the '540 patent requires a packing means disposed on said mandrel for sealingly engaging the well bore. The '266 tool does sealingly engage the well bore – the '266 plug has rubber rings that engage the well bore when compressed "thus forming a packer or seal to prevent the leakage of fluid between the exterior surface of the segments 10 and the casing." App. at W000214, lines 70-73.

Halliburton's attorney further argued at the preliminary injunction hearing that the '266 plug does not sealingly engage the well bore because the spaces between the tool's wooden segments[4] form leak paths. The proper inquiry for a claim to be invalid on the basis of anticipation requires that "all of the elements and limitations of the claim be shown in a single prior art reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001). The language of the '266 patent discloses a tool that sealingly engages the well casing or well bore, therefore Halliburton's argument that the '266 plug does not actually seal the well bore fails to rebut Weatherford's invalidity defense.

Next, Halliburton argues that the '266 bridging plug does not have a plurality of slips disposed on the mandrel, rather the slips are on the tool's segments. In this argument, Halliburton mischaracterizes its claims. Claim 1 of the '468 patent requires "a plurality of

[4]See footnote 3 for a description of segments.

slips disposed *around* said mandrel." Dispose means "to place or set in a particular order" or "to arrange." *See* THE AMERICAN HERITAGE® DICTIONARY OF THE ENGLISH LANGUAGE (4th ed. 2000). The slips of the '266 tool are placed or arranged around the mandrel. Claim 30 of the '468 patent and claim 1 of the '540 patent require that the *slip means*, rather than the slips themselves, is disposed on the mandrel. This argument fails for the purpose of determining this motion because the term "disposed on" does not require that the slip means be physically attached to the mandrel. The slip means of the '266 plug is arranged on the mandrel. Halliburton's argument regarding the disposition of the '266 slips thus fails.

Lastly, Halliburton asserts that the '266 tool does not have a seal member on the mandrel. Halliburton's patent claims, however, require only that a "packing means" be disposed on the mandrel. The rubber rings of the '266 patent are arranged on the mandrel, therefore Halliburton's defense fails. Halliburton, thus, has not shown that Weatherford's defense of anticipation fails. Halliburton's motion for preliminary injunction is denied, because Weatherford raised a substantial question regarding the validity of the relevant claims of Halliburton's '468 and '540 patents.

B. Obviousness of the '468 and '540 Patents

The Defendants also argue that prior art renders the relevant claims of Halliburton's patents-in-suit obvious. A patent claim will be invalid if it is obvious to one of ordinary skill in the pertinent art:

> [a] patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at

> the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. §103(a) (2003). The determination of obviousness can be made by comparing the claimed device to a single prior art reference. However, the obviousness determination is often made by comparing the claimed device to a combination of references. *Karsten Mfg. Corp.*, 242 F.3d at 1385. "In holding an invention obvious in view of a combination of references, there must be some suggestion, motivation, or teaching in the prior art that would have led a person of ordinary skill in the art to select the references and combine them in the way that would produce the claimed invention." *Id.* The Defendants argue in their responses and surreplies that a number of publications either alone, or in combination, render both the '468 and '540 patents obvious.

1. Baker Tools

Both Defendants argue in their briefs that publications describing Baker Oil Tools' ("Baker") Prime Fiberglass Packer[5] and AD-Type Fiberglass Packer (collectively the "Baker tools") render obvious claims 1 and 30 of the '468 patent and claims 1 and 2 of the '540 patent. Baker's 1968 Special Products Manual discloses the Baker Fiberglass Packer and a 1968 World Oil Advertisement (collectively "Baker references") discloses both Baker tools. The Baker references predate the filing of the '468 and '540 patents by more than twenty years, and the patent examiner did not consider these materials during the prosecution of

[5]For the purposes of this opinion, packers and bridge plugs are considered to be similar downhole oil well tools.

Halliburton's patents-in-suit. These references appear to raise a substantial question about the validity of some of the relevant claims of Halliburton's patents.

The components of the Baker tools include a packing element and a plurality of slips disposed around a center mandrel. All components of the Prime Fiberglass Packer are constructed of non-metallic substances, and the mandrel of the AD-Type Fiberglass Packer is made of a non-metallic substance. Halliburton argues that the Baker tools could not be positioned into a locking, sealing engagement with the well bore. However, the function of the slips is to "bite into the casing" or lockingly engage the well bore, and the packing element is designed to sealingly engage the well bore. The incorporation of these design elements coupled with the description in the Special Products Manual for "running" or setting the tool suggest that the Baker tools could be positioned into a locking, sealing engagement with the well bore.

Halliburton further argues that the Baker tools do not have the necessary element of a slip support on the opposite side of the cone as part of the slip means. As discussed above, a slip support opposite the cone is not a necessary element of "slip means" for the purposes of deciding this motion. Thus, the Baker tools' slip mechanism is consistent with the defined term "slip means." The Baker references, therefore, anticipate or render obvious claim 30 of the '468 patent and claims 1 and 2 of the '540 patent.

The Baker references do not disclose the drill out element in claim 1 of '468 patent. The Defendants argue that persons skilled in the art knew to drill out bridge plugs from well bores if the tools became stuck. The Baker references coupled with this general knowledge

do not render obvious Halliburton's method claim. Claim 1 of the '468 patent describes a process for routinely setting a well tool and then drilling it out. The abnormal drill out of a malfunctioning bridge plug is not a customary part of the process for setting the Baker tools nor is there any suggestion in the references themselves that the Baker tools could or should be drilled out. The Baker references and the knowledge of abnormal plug drill outs do not render obvious claim 1 of the '468 patent.

The Defendants also argue that the Baker references, combined with other prior art, such as United States Patent Number 4,708,202 (the " '202" patent), suggest routine drill out of bridge plugs. The '202 patent and the '266 patent discussed above disclose that drilling out downhole tools, such as packers and bridge plugs, constructed of non-metallic components is desirable. These patents specifically state that non-metallic components improve the drillabillity of well tools. The coupling of the Baker references with either the '202 patent or the '266 patent renders claim 1 of the '468 patent obvious.

2. Other Prior Art References

The Defendants also argue that other prior art references, taken together with the Baker references, render the relevant claims of the patents-in-suit obvious. The Defendants state that the '202 patent, entitled "Drillable Well-Fluid Flow Control Tool," issued on November 24, 1987 discloses every element and limitation of Halliburton's claim 1 and 30 of the '468 patent and claims 1 and 2 of the '540 patent except the non-metallic mandrel or slips. The Baker references, Defendants argue, coupled with the '202 patent render these claims obvious. Additionally, the '202 patent itself discusses "forming a number of the

components of the tool from [non-metallic substances]" to improve the tools' drillability. App. Pl. at 000130, col. 7, l. 23-27. This language suggests forming tool components, such as the mandrel or slips, from non-metallic substances, and the Baker Special Products Manual discloses packers constructed entirely of non-metallic substances. The '202 patent and the Baker references, therefore, raise a substantial question as to the validity of claims 1 of the '468 patent and claims 1 and 2 of the '540 patent.

Defendants also argue United States Patent Number 3,306,366 (the " '366 patent"), entitled "Well Packer Apparatus," issued on February 28, 1967 discloses the common geometry of well tools with slips above and below the packing means that act in opposite directions. This slip geometry is consistent with the '266 patent discussed above. The upper slip assembly prevents the plug from moving upward in the well and the lower slip assembly prevents downward movement. The combination of the Baker references with the slip geometry disclosed in both the '875 and '266 patent appears to raise a substantial question as to the validity of claim 3 of the '540 patent.

Whether a claim would have been obvious within the meaning of 35 U.S.C. § 103 is a question of law based on underlying findings of fact including: the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art. In light of these factual determinations discussed above, the relevant claims of Halliburton's patents-in-suit are obvious. Secondary considerations such as commercial success, long felt but unsolved needs, failure of others, copying and unexpected results may also be utilized "to give light to the circumstances surrounding the

origin of the subject matter sought to be patented." *Graham v. John Deere Co.* U.S. 1, 17-18 (1966). These secondary factors favor a finding of nonobviousness of Halliburton's patents-in-suit: Halliburton's FAS DRILL® tools have enjoyed commercial success; the marketplace needed an easily drillable bridge plug; others, such as Mr. Harris, attempted but failed in designing and testing such a drillable tool; and Halliburton has presented evidence of the alleged copying of its FAS DRILL® tools by the Defendants. However, the factual determinations pertaining to the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art overcome the secondary considerations. The Defendants, therefore, have raised a substantial question regarding the obviousness of the relevant claims of Halliburton's patents-in-suit.

III. CONCLUSION

The Defendants have shown a substantial question regarding the validity of relevant claims of the patents-in-suit. The '266 patent anticipates claims 1 and 30 of the '468 patent and claims 1-3 of the '540 patent. The Baker references alone anticipate or render obvious claim 30 of the '468 patent and claims 1 and 2 of the '540 patent. The Baker references taken together with the '202 patent or '266 patent render obvious claim 1 of the '468 patent and claims 1 and 2 of the '540 patent. Lastly, the Baker references and the '366 or '266 patent render obvious claim 3 of the '540 patent.

Halliburton has not show that the Defendants' attacks on its patents lack substantial merit. Thus, Halliburton has not demonstrated a likelihood of success on the merits of its claims at trial. Therefore, Halliburton's motion for a preliminary injunction is denied.[6]

SIGNED this 4 day of March, 2003.

David C. Godbey
United States District Judge

[6]In light of this order, (1) Halliburton's motion for expedited discovery filed on June 27, 2002, (2) Halliburton's motion for temporary restraining order filed on June 27, 2002, (3) Weatherford's and BJ's motion for enlargement of time filed on July 1, 2002, (4) Halliburton's motion to strike filed on August 27, 2002, (5) Weatherford's motion to strike the declarations in support of Halliburton's requests for preliminary relief filed on September 11, 2002, and (6) Weatherford's motion to strike Halliburton's consolidated response to Defendants' sur-replies or, alternatively, motion for leave to file a reply brief filed on September 11, 2002 are denied as moot.

ORIGINAL

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

NORTHERN DISTRICT OF TEXAS
AUG 26
CLERK, U.S. DISTRICT COURT
By ______________
Deputy

HALLIBURTON ENERGY SERVICES, INC.,	§	
Plaintiff,	§	
v.	§	Civil Action No. 3-02-CV-1347-N
WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY,	§	
Defendants.	§	

ORDER

Before the Court is Plaintiff Halliburton Energy Services, Inc.'s ("Halliburton") motion for reconsideration of the Court's memorandum opinion and order, entered March 5, 2003, ("Order") denying Halliburton's motion for preliminary injunction. Though Halliburton identifies neither the procedural basis nor the standard for its motion, the Court will consider it a motion to alter or amend judgment pursuant to Federal Rule of Civil Procedure 59(e). *See Lavespere v. Niagra Machine & Tool Works, Inc.*, 910 F.2d 167, 173 (5th Cir. 1990), *cert. denied*, 510 U.S. 859 (1993). Halliburton argues in its motion that it is entitled to reconsideration because of an intervening change in the law controlling the Court's denial of its motion for preliminary injunction, citing *Amgen, Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313 (Fed. Cir. 2003).[1] The Court denies Halliburton's motion to

[1]Halliburton offers additional grounds for reconsideration in its reply, however, the grounds are not proper under Rule 59(e), *see In re Benjamin Moore & Co.*, 318 F.3d 626, 629 (5th Cir. 2002), and the Court will not consider an argument raised for the first time in a reply

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alter or amend judgment because the Federal Circuit's decision in *Amgen* did not change the controlling law.

The Court denied Halliburton's motion for preliminary injunction, in part, because Defendant Weatherford International, Inc. ("Weatherford") raised a substantial question regarding the validity of the patents-in-suit; Weatherford argued that United States Patent Number 1,684,266, entitled Bridging Plug, issued on September 11, 1928, (the " '266 patent") anticipated the patents-in-suit. Because Halliburton did not show that Weatherford's attack on its patents lacked substantial merit, Halliburton could not demonstrate a likelihood of success on the merits of its claims, and the Court denied its motion for preliminary injunction.

Halliburton now argues and offers evidence for the first time that the '266 Patent does not anticipate the patents-in-suit because it is not enabling. Specifically, Halliburton asserts that the '266 Patent is not enabling because the tool disclosed does not seal the well bore. Halliburton's excuse for its belated argument is that the law pertaining to the party with the burden of showing that the '266 Patent is or is not enabling changed; Halliburton states that it relied upon the treatise *Chisum on Patents* for the proposition that a patent validity challenger must initially bear the burden of producing some evidence that a reference, such as the '266 Patent, is enabling. *See* CHISUM ON PATENTS § 3.04 [1][b][v], at 3-102 to 3-103 (2002) ("Chisum"). The Federal Circuit in *Amgen*, Halliburton argues, changed Professor Chisum's understanding of the law and held that a patentee bears the burden of offering

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brief. *See Lacher v. West*, 147 F. Supp. 2d 538, 540 & n.2 (N.D. Tex. 2001).

evidence of whether prior art, cited as evidence of invalidity, fails to enable the claimed invention. *See Amgen*, 314 F.3d at 1355. Halliburton's argument is unpersuasive.

First, though Professor Chisum is an expert in the area of patent law and his treatise an esteemed secondary source, it does not constitute *controlling* precedent; though courts may choose to adopt his rationale, they are by no means bound by it. Second, Halliburton's *Chisum* reference does not state definitively that the law pertaining to the burden of proof on enablement is settled; quite to the contrary, *Chisum* cites several district court opinions that presume a prior art reference to be enabling, thereby requiring the patentee to initially produce some evidence that the prior art fails to enable the claimed invention. CHISUM at n. 53. *Chisum* then disagreed with the cited district court opinions and, by analogizing to presumptions in other legal contexts, hypothesized that the Federal Circuit would require a validity challenger to first produce some evidence that a prior art reference is enabling. Thus, Halliburton's argument that it was misled by *Chisum* or even the state of controlling law is unpersuasive; *Chisum* acknowledged the different approaches to the burden of proof on the enabling quality of a prior art reference and gave its best guess on what the Federal Circuit would decide.

Third, even assuming Halliburton was somehow confused or misled as to the controlling law, the illustrative case cited in *Chisum* for the proposition that a validity challenger must first produce some evidence that a reference is enabling states:

> Since the burden is always on the challenger to show invalidity by clear and convincing evidence, once [the accused infringer] has shown that each and every claim is cited in [a cited prior art] reference, i.e., identity, [the patentee] only has the burden of producing some material evidence which places the

> enablement of the reference in question. Once it has done so, [the accused infringer] must show by clear and convincing evidence that the reference was, in fact, enabling.

CHISUM (internal citations omitted, quoting *Abbott Labs. v. Diamedix Corp.*, 969 F. Supp. 1064 (N.D. Ill. 1997)). Contrary to the relevant case law, Halliburton did not produce some material evidence which placed the enablement of the reference in question. Indeed, it did not even raise this issue in its briefs, rather only in oral argument without evidentiary support.

Fourth, the holding in *Amgen* is not directly on point and thus is not controlling law within the meaning of Rule 59(e). The court and the parties in *Amgen* agreed that under section 282, 35 U.S.C. § 282, the claims of a prior art patent are presumed enabling. Here the claims of the '266 Patent disclose that the tool seals the well bore. *See* '266 Patent, claims 2, 3, and 6. The Federal Circuit in *Amgen* addressed the presumption of enablement in the context of a patent's unclaimed disclosures. Therefore, *Amgen* is not controlling law for the purposes of Rule 59(e). Fifth, *Amgen* did not purport to change the law pertaining to the presumption of enablement for prior art references, rather the Federal Circuit relied on established precedent. *See Amgen,* 314 F.3d at 1355.

Lastly, in applying for the extraordinary remedy of preliminary injunction, Halliburton had the burden of establishing a likelihood of success on the merits. As part of that burden, Halliburton had to show that Weatherford's attack on its patents lacked substantial merit. Notwithstanding this burden, Halliburton failed to raise in its briefs or to produce any evidence on the failure of the '266 Patent as an enabling disclosure. Halliburton cannot now blame Professor Chisum for its failure to offer evidence that the '266 Patent was not

enabling. Halliburton's motion to alter or amend judgment is therefore DENIED.[2]

SIGNED this 26 day of August, 2003.

David C. Godbey, District Judge

[2]In light of this Order, Halliburton's motion for admission of the '266 Model, filed on May 12, 2003, is DENIED, Defendant BJ Services Company's motion to strike, filed April 7, 2003, is DENIED as moot, and Weatherford's motion for leave to file its submission of additional rebuttal evidence in response to Halliburton's motion for reconsideration, filed August 22, 2003, is DENIED as moot.

US005271468A

United States Patent [19]

Streich et al.

[11] **Patent Number:** 5,271,468

[45] **Date of Patent:** Dec. 21, 1993

[54] DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

[75] Inventors: Steven G. Streich; Donald F. Hushbeck; Kevin T. Berscheidt; Rick D. Jacobi, all of Duncan, Okla.

[73] Assignee: Halliburton Company, Duncan, Okla.

[21] Appl. No.: 719,740

[22] Filed: Jun. 21, 1991

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 515,019, Apr. 26, 1990, abandoned.

[51] Int. Cl.[5] E21B 33/129

[52] U.S. Cl. 166/387; 166/118; 166/134; 166/217; 166/376; 175/57

[58] Field of Search 166/376, 387, 118, 135, 166/134, 138, 179, 192, 382, 123, 128, 242; 175/57

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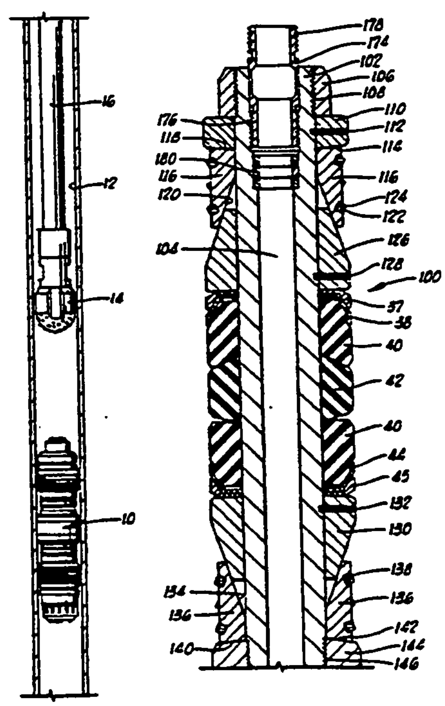
Primary Examiner—Stephen J. Novosad

[57] **ABSTRACT**

A downhole tool apparatus and methods of drilling the apparatus. The apparatus may include, but is not limited to, packers and bridge plugs utilizing non-metallic components. The material may include engineering grade plastics. The nonmetallic components may include but are not limited to the center mandrel, slips, slip wedges, slip supports and housings, spacer rings, valve housings and valve components. Methods of drilling out the apparatus without significant variations in the drilling speed and weight applied to the drill bit may be employed. Alternative drill bit types, such as polycrystalline diamond compact (PDC) bits may also be used.

75 Claims, 6 Drawing Sheets



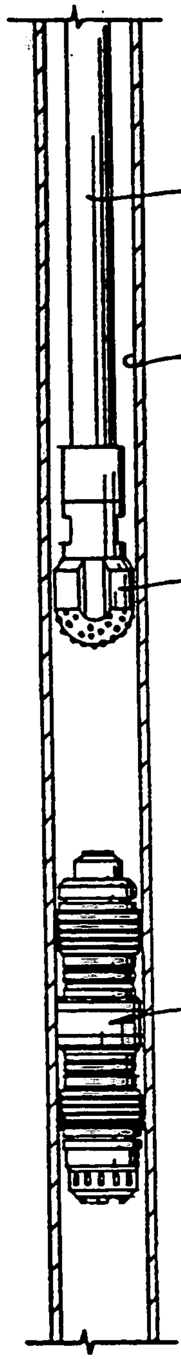

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FIG. 1

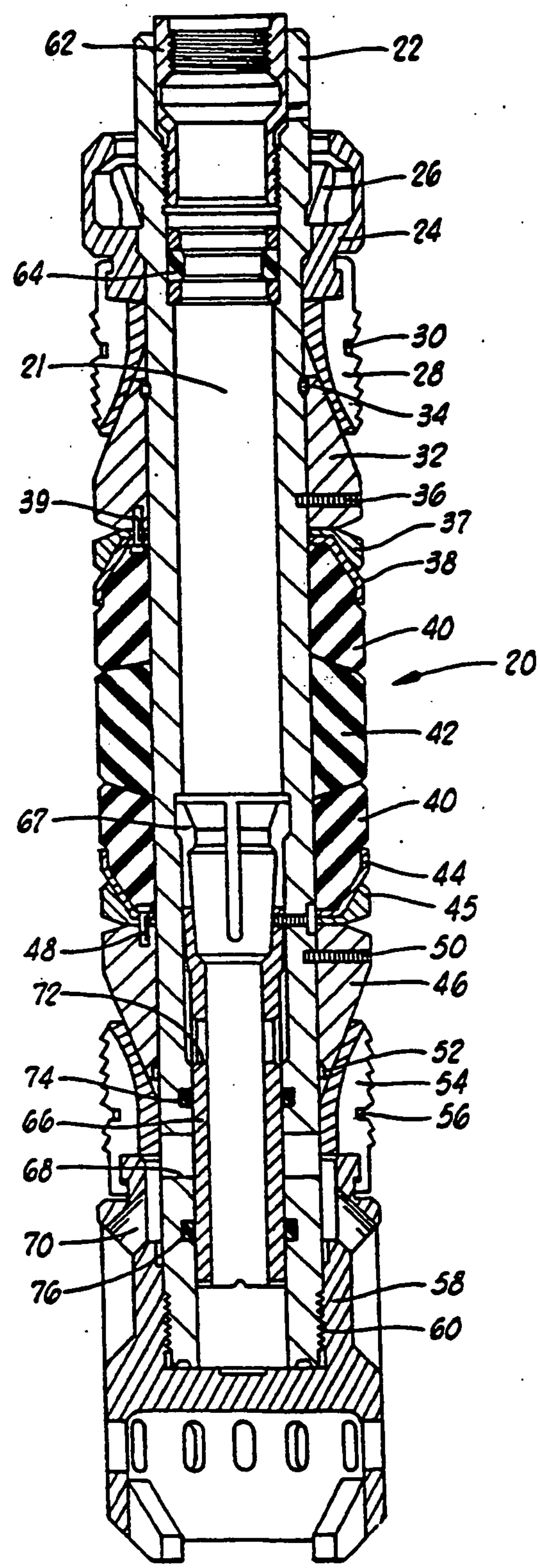
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FIG. 2

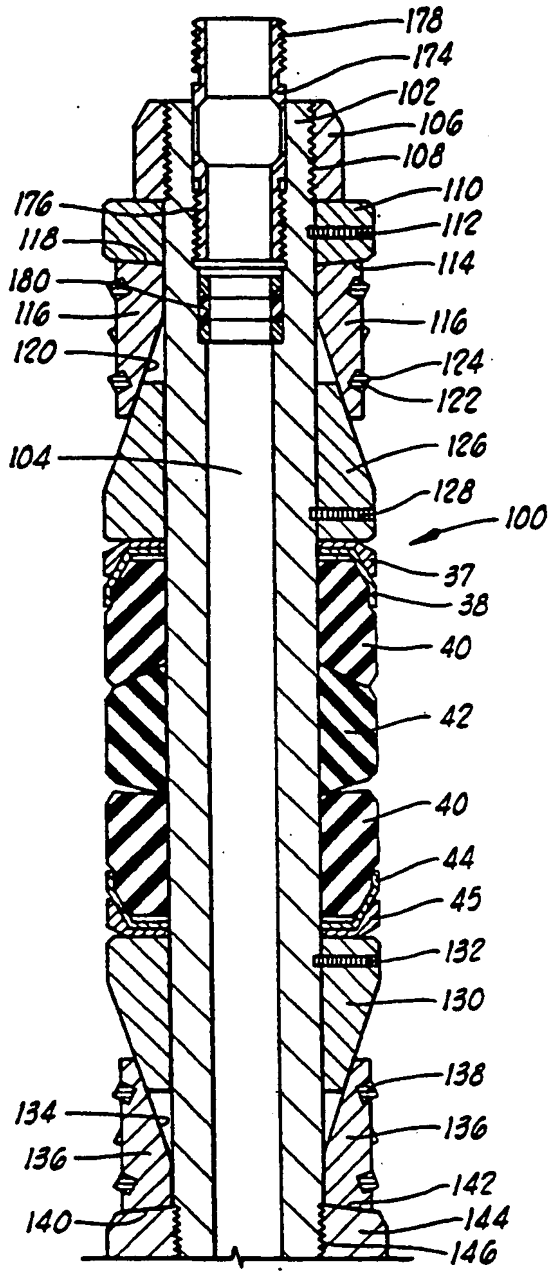
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FIG. 3A

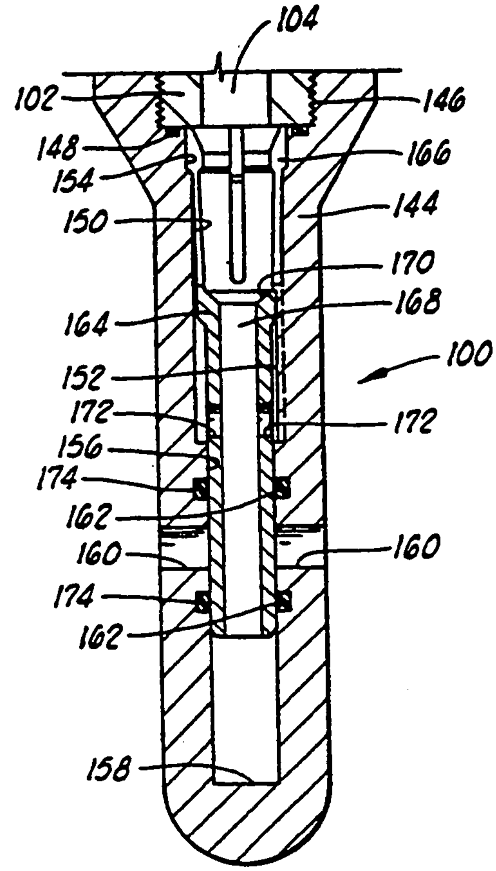
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FIG. 3B

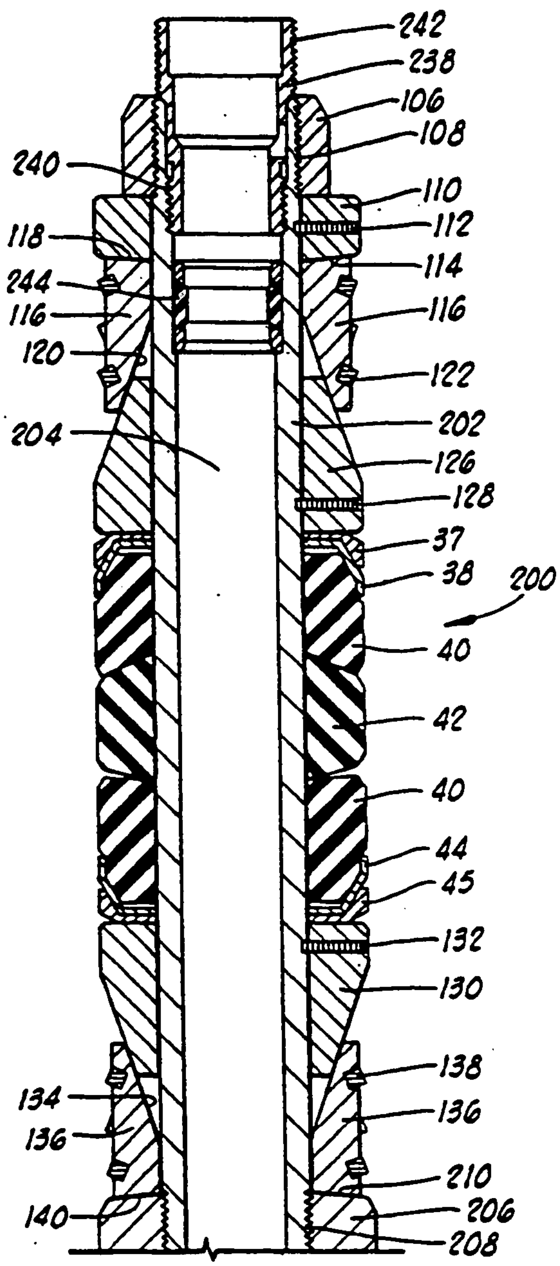
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FIG. 4A

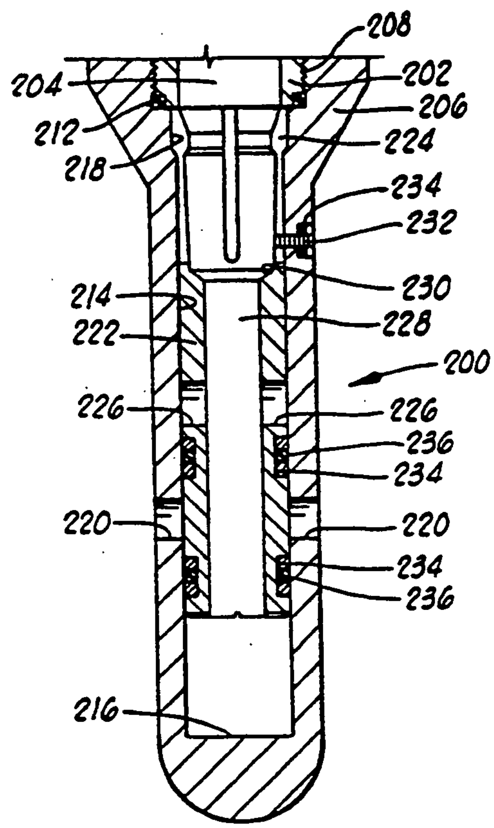
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FIG. 4B

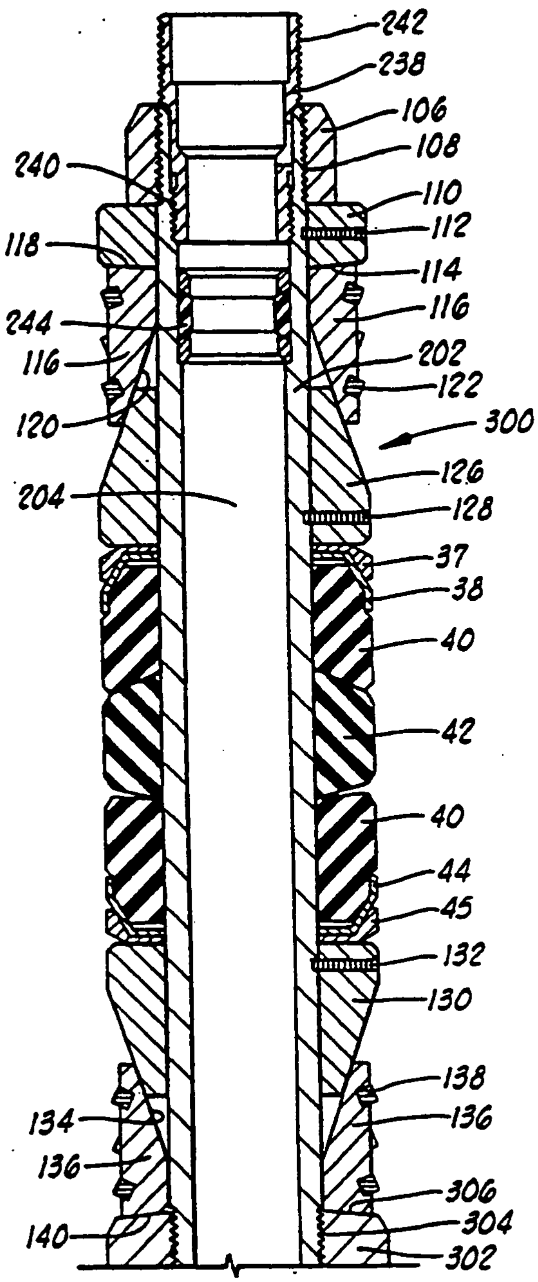
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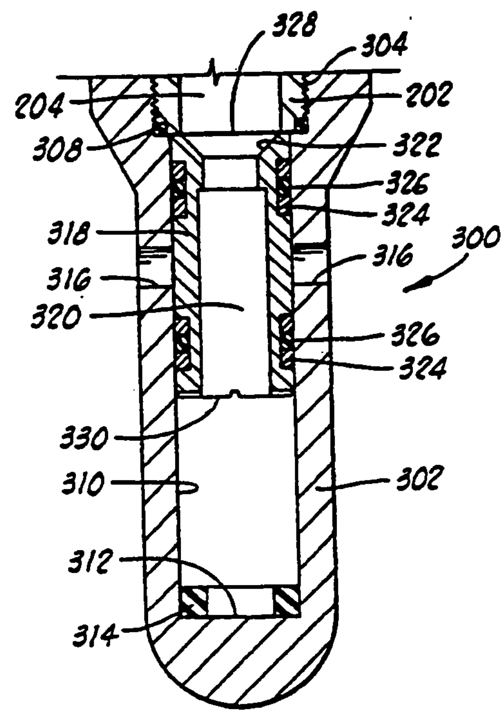
FIG. 5A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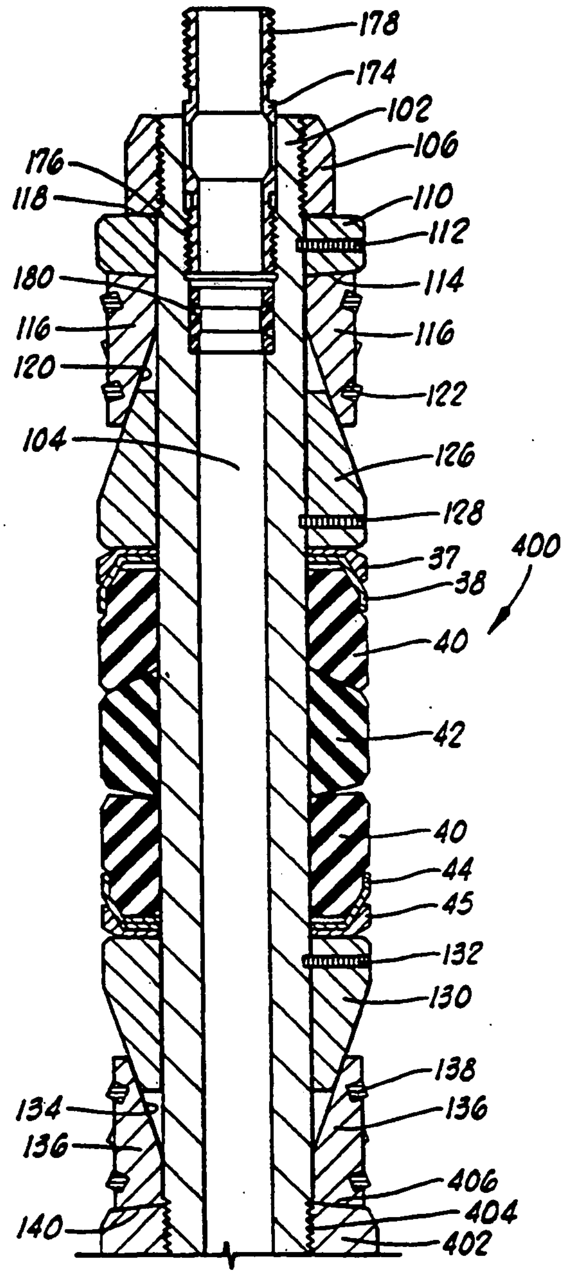
326
324
330
310
302
312
314

FIG. 5B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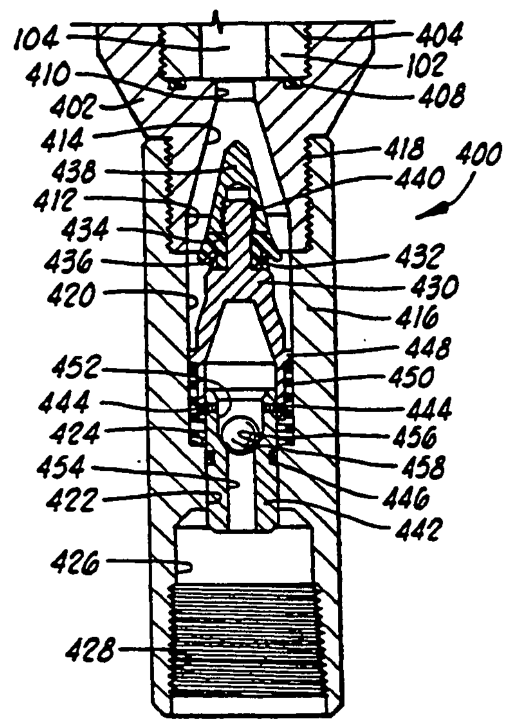
174
102
106
176
118
110
112
180
114
116
116
120
122
104
126
128
37
400
38
40
42
40
44
45
132
130
138
134
136
136
406
404
140
402

FIG. 6A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404
410
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402
408
414
418
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438
440
412
434
432
436
430
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452
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444
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424
456
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458
422
446
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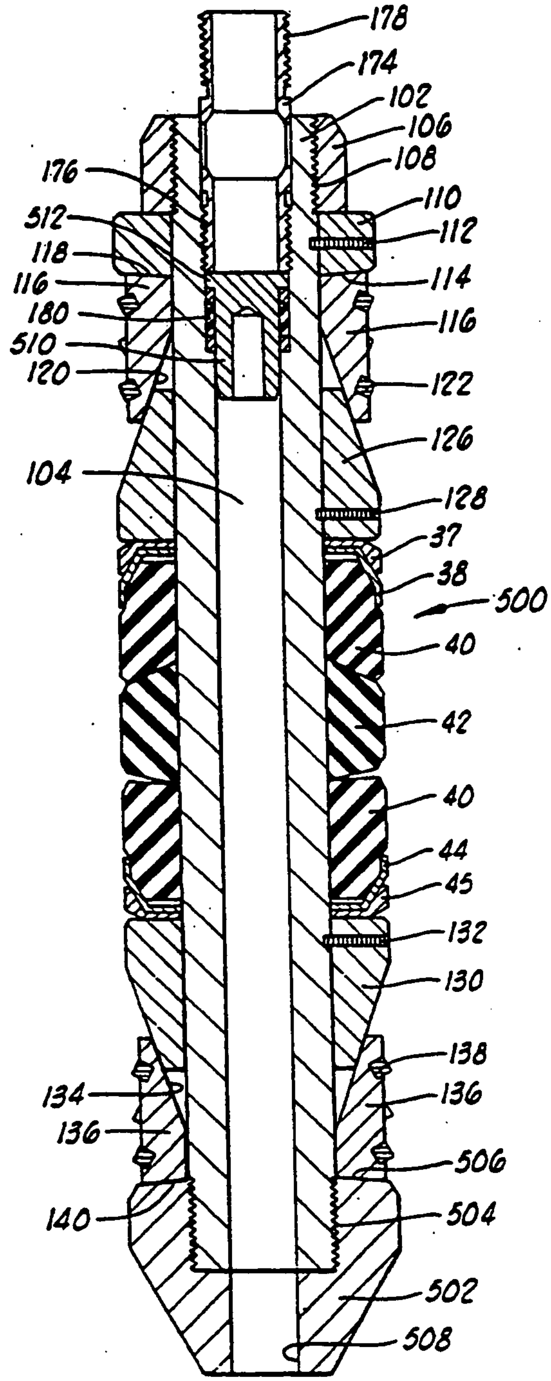
426
428

FIG. 6B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174
102
106
108
176
110
512
112
118
114
116
116
180
510
120
122
126
104
128
37
38
500
40
42
40
44
45
132
130
138
134
136
136
506
140
504
502
508

FIG. 7

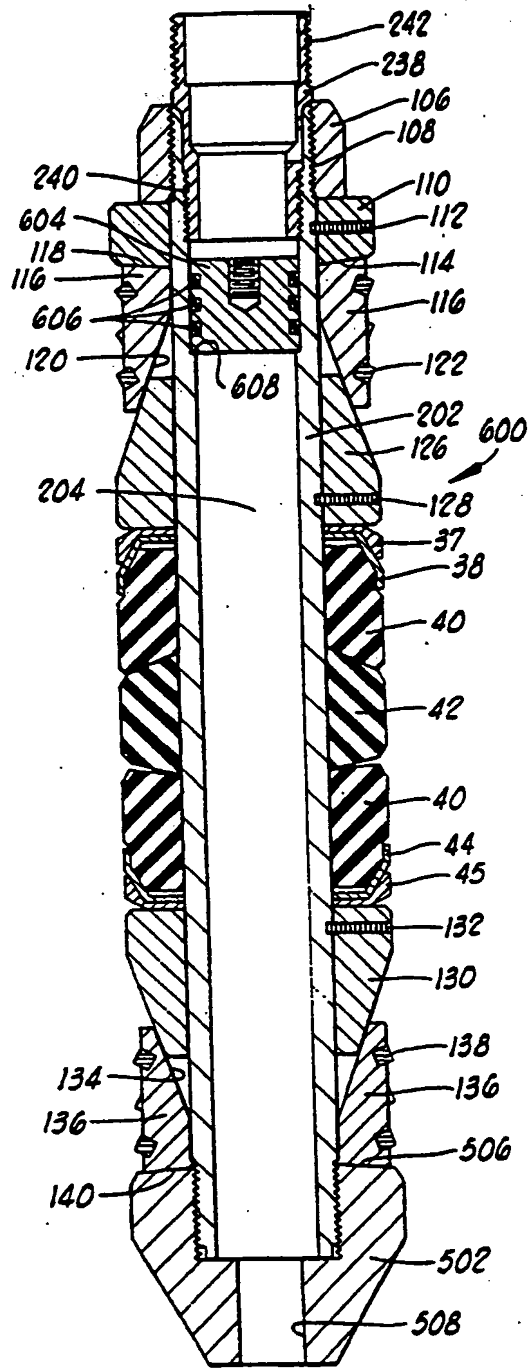
242
238
106
108
240
110
604
112
118
114
116
116
606
120
122
608
202
126
600
204
128
37
38
40
42
40
44
45
132
130
138
134
136
136
506
140
502
508

FIG. 8

DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

This application is a continuation-in-part of co-pending application Ser. No. 07/515,019, filed Apr. 26, 1990 now abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to downhole tools for use in well bores and methods of drilling such apparatus out of well bores, and more particularly, to such tools having drillable components therein made of non-metallic materials, such as engineering grade plastics.

2. Description Of The Prior Art

In the drilling or reworking of oil wells, a great variety of downhole tools are used. For example, but not by way of limitation, it is often desirable to seal tubing or other pipe in the casing of the well, such as when it is desired to pump cement or other slurry down tubing and force the slurry out into a formation. It then becomes necessary to seal the tubing with respect to the well casing and to prevent the fluid pressure of the slurry from lifting the tubing out of the well. Packers and bridge plugs designed for these general purposes are well known in the art.

When it is desired to remove many of these downhole tools from a well bore, it is frequently simpler and less expensive to mill or drill them out rather than to implement a complex retrieving operation. In milling, a milling cutter is used to grind the packer or plug, for example, or at least the outer components thereof, out of the well bore. Milling is a relatively slow process, but it can be used on packers or bridge plugs having relatively hard components such as erosion-resistant hard steel. One such packer is disclosed in U.S. Pat. No. 4,151,875 to Sullaway, assigned to the assignee of the present invention and sold under the trademark EZ Disposal packer. Other downhole tools in addition to packers and bridge plugs may also be drilled out.

In drilling, a drill bit is used to cut and grind up the components of the downhole tool to remove it from the well bore. This is a much faster operation than milling, but requires the tool to be made out of materials which can be accommodated by the drill bit. Typically, soft and medium hardness cast iron are used on the pressure bearing components, along with some brass and aluminum items. Packers of this type include the Halliburton EZ Drill ® and EZ Drill SV ® squeeze packers.

The EZ Drill SV ® squeeze packer, for example, includes a lock ring housing, upper slip wedge, lower slip wedge, and lower slip support made of soft cast iron. These components are mounted on a mandrel made of medium hardness cast iron. The EZ Drill ® squeeze packer is similarly constructed. The Halliburton EZ Drill ® bridge plug is also similar, except that it does not provide for fluid flow therethrough.

All of the above-mentioned packers are disclosed in Halliburton Services Sales and Service Catalog No. 43, pages 2561–2562, and the bridge plug is disclosed in the same catalog on pages 2556–2557.

The EZ Drill ® packer and bridge plug and the EZ Drill SV ® packer are designed for fast removal from the well bore by either rotary or cable tool drilling methods. Many of the components in these drillable packing devices are locked together to prevent their spinning while being drilled, and the harder slips are grooved so that they will be broken up in small pieces. Typically, standard "tri-cone" rotary drill bits are used which are rotated at speeds of about 75 to about 120 rpm. A load of about 5,000 to about 7,000 pounds of weight is applied to the bit for initial drilling and increased as necessary to drill out the remainder of the packer or bridge plug, depending upon its size. Drill collars may be used as required for weight and bit stabilization.

Such drillable devices have worked well and provide improved operating performance at relatively high temperatures and pressures. The packers and plug mentioned above are designed to withstand pressures of about 10,000 psi and temperatures of about 425° F. after being set in the well bore. Such pressures and temperatures require the cast iron components previously discussed.

However, drilling out iron components requires certain techniques. Ideally, the operator employs variations in rotary speed and bit weight to help break up the metal parts and reestablish bit penetration should bit penetration cease while drilling. A phenomenon known as "bit tracking" can occur, wherein the drill bit stays on one path and no longer cuts into the downhole tool. When this happens, it is necessary to pick up the bit above the drilling surface and rapidly recontact the bit with the packer or plug and apply weight while continuing rotation. This aids in breaking up the established bit pattern and helps to reestablish bit penetration. If this procedure is used, there are rarely problems. However, operators may not apply these techniques or even recognize when bit tracking has occurred. The result is that drilling times are greatly increased because the bit merely wears against the surface of the downhole tool rather than cutting into it to break it up.

While cast iron components may be necessary for the high pressures and temperatures for which they are designed, it has been determined that many wells experience pressures less than 10,000 psi and temperatures less than 425° F. This includes most wells cemented. In fact, in the majority of wells, the pressure is less than about 5,000 psi, and the temperature is less than about 250° F. Thus, the heavy duty metal construction of the previous downhole tools, such as the packers and bridge plugs described above, is not necessary for many applications, and if cast iron components can be eliminated or minimized, the potential drilling problems resulting from bit tracking might be avoided as well.

The downhole tool of the present invention solves this problem by providing an apparatus wherein at least some of the components, including pressure bearing components, are made of non-metallic materials, such as engineering grade plastics. Such plastic components are much more easily drilled than cast iron, and new drilling methods may be employed which use alternative drill bits such as polycrystalline diamond compact bits, or the like, rather than standard tri-cone bits.

SUMMARY OF THE INVENTION

The downhole tool apparatus of the present invention utilizes non-metallic materials, such as engineering grade plastics, to reduce weight, to reduce manufacturing time and labor, to improve performance through reducing frictional forces of sliding surfaces, to reduce costs and to improve drillability of the apparatus when drilling is required to remove the apparatus from the well bore. Primarily, in this disclosure, the downhole

tool is characterized by well bore packing apparatus, but it is not intended that the invention be limited to such packing devices. The non-metallic components in the downhole tool apparatus also allow the use of alternative drilling techniques to those previously known.

In packing apparatus embodiments of the present invention, the apparatus may utilize the same general geometric configuration of previously known drillable packers and bridge plugs while replacing at least some of the metal components with non-metallic materials which can still withstand the pressures and temperatures exposed thereto in many well bore applications. In other embodiments of the present invention, the apparatus may comprise specific design changes to accommodate the advantages of plastic materials and also to allow for the reduced strengths thereof compared to metal components.

In one embodiment of the downhole tool, the invention comprises a center mandrel and slip means disposed on the mandrel for grippingly engaging the well bore when in a set position. In packing embodiments, the apparatus further comprises a packing means disposed on the mandrel for sealingly engaging the well bore when in a set position.

The slip means may comprise a wedge engaging a plurality of slips with a slip support on the opposite side of the slips from the wedge. Any of the mandrel, slips, slip wedges or slip supports may be made of the non-metallic material, such as plastic. Specific plastics include nylon, phenolic materials and epoxy resins. The phenolic materials may further include any of Fiberite FM4056J, Fiberite FM4005 or Resinoid 1360. The plastic components may be molded or machined.

One preferred plastic material for at least some of these components is a glass reinforced phenolic resin having a tensile strength of about 18,000 psi and a compressive strength of about 40,000 psi, although the invention is not intended to be limited to this particular plastic or a plastic having these specific physical properties. The plastic materials are preferably selected such that the packing apparatus can withstand well pressures less than about 10,000 psi and temperatures less than about 425° F. In one preferred embodiment, but not by way of limitation, the plastic materials of the packing apparatus are selected such that the apparatus can withstand well pressures up to about 5,000 psi and temperatures up to about 250° F.

Most of the components of the slip means are subjected to substantially compressive loading when in a sealed operating position in the well bore, although some tensile loading may also be experienced. The center mandrel typically has tensile loading applied thereto when setting the packer and when the packer is in its operating position.

One new method of the invention is a well bore process comprising the steps of positioning a downhole tool into engagement with the well bore; prior to the step of positioning, constructing the tool such that a component thereof is made of a non-metallic material; and then drilling the tool out of the well bore. The tool may be selected from the group consisting packers and bridge plugs, but is not limited to these devices.

The component made of non-metallic material, may be one of several such components. The components may be substantially subject to compressive loading. Such components in the tool may include lock ring housings, slips, slip wedges and slip supports. Some components, such as center mandrels of such tools may be substantially subjected to tensile loading.

In another embodiment, the step of drilling is carried out using a polycrystalline diamond compact bit. Regardless of the type of drill bit used, the process may further comprise the step of drilling using a drill bit without substantially varying the weight applied to the drill bit.

In another method of the invention, a well bore process comprises the steps of positioning and setting a packing device in the well bore, a portion of the device being made of engineering grade plastic; contacting the device with well fluids; and drilling out the device using a drill bit having no moving parts such as a polycrystalline diamond compact bit. This or a similar drill bit might have been previously used in drilling the well bore itself, so the process may be said to further comprise the step of, prior to the step of positioning and setting the packer, drilling at least a portion of the well bore using a drill bit such as a polycrystalline diamond compact bit.

In one preferred embodiment, the step of contacting the packer is at a pressure of less than about 5,000 psi and a temperature of less than about 250° F, although higher pressures and temperatures may also be encountered.

It is an important object of the invention to provide a downhole tool apparatus utilizing components made of nonmetallic materials and methods of drilling thereof.

It is another object of the invention to provide a well bore packing apparatus using components made of engineering grade plastic.

An additional object of the invention is to provide a packing apparatus having a valve housing disposed substantially below a lower end of a center mandrel and having a valve in the valve housing below the lower end of the center mandrel.

It is a further object of the invention to provide a packing apparatus which may be drilled by alternate methods to those using standard rotary drill bits.

Additional objects and advantages of the invention will become apparent as the following detailed description of the preferred embodiments is read in conjunction with the drawings which illustrate such preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 generally illustrates the downhole tool of the present invention positioned in a well bore with a drill bit disposed thereabove.

FIG. 2 illustrates a cross section of one embodiment of a drillable packer made in accordance with the invention.

FIGS. 3A and 3B show a cross section of a second embodiment of a drillable packer.

FIGS. 4A and 4B show a third drillable packer embodiment.

FIGS. 5A and 5B illustrate a fourth embodiment of a drillable packer.

FIGS. 6A and 6B show a fifth drillable packer embodiment with a poppet valve therein.

FIG. 7 shows a cross section of one embodiment of a drillable bridge plug made in accordance with the present invention.

FIG. 8 illustrates a second embodiment of a drillable bridge plug.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to FIG. 1, the downhole tool apparatus of the present invention is shown and generally designated by the numeral 10. Apparatus 10, which may include, but is not limited to, packers, bridge plugs, or similar devices, is shown in an operating position in a well bore 12. Apparatus 10 can be set in this position by any manner known in the art such as setting on a tubing string or wire line. A drill bit 14 connected to the end of a tool or tubing string 16 is shown above apparatus 10 in a position to commence the drilling out of apparatus 10 from well bore 12. Methods of drilling will be further discussed herein.

First Packer Embodiment

Referring now to FIG. 2, the details of a first squeeze packer embodiment 20 of apparatus 10 will be described. The size and configuration of packer 20 is substantially the same as the previously mentioned prior art EZ Drill SV® squeeze packer. Packer 20 defines a generally central opening 21 therein.

Packer 20 comprises a center mandrel 22 on which most of the other components are mounted. A lock ring housing 24 is disposed around an upper end of mandrel 22 and generally encloses a lock ring 26.

Disposed below lock ring housing 24 and pivotally connected thereto are a plurality of upper slips 28 initially held in place by a retaining band 30. A generally conical upper slip wedge is disposed around mandrel 22 adjacent to upper slips 30. Upper slip wedge 32 is held in place on mandrel 22 by a wedge retaining ring 34 and a plurality of screws 36.

Adjacent to the lower end of upper slip wedge 32 is an upper back-up ring 37 and an upper packer shoe 38 connected to the upper slip wedge by a pin 39. Below upper packer shoe 38 are a pair of end packer elements 40 separated by center packer element 42. A lower packer shoe 44 and lower back-up ring 45 are disposed adjacent to the lowermost end packer element 40.

A generally conical lower slip wedge 46 is positioned around mandrel 22 adjacent to lower packer shoe 44, and a pin 48 connects the lower packer shoe to the lower slip wedge.

Lower slip wedge 46 is initially attached to mandrel 22 by a plurality of screws 50 and a wedge retaining ring 52 in a manner similar to that for upper slip wedge 32. A plurality of lower slips 54 are disposed adjacent to lower slip wedge 46 and are initially held in place by a retaining band 56. Lower slips 54 are pivotally connected to the upper end of a lower slip support 58. Mandrel 22 is attached to lower slip support 58 at threaded connection 60.

Disposed in mandrel 22 at the upper end thereof is a tension sleeve 62 below which is an internal seal 64. Tension sleeve 62 is adapted for connection with a setting tool (not shown) of a kind known in the art.

A collet-latch sliding valve 66 is slidably disposed in central opening 21 at the lower end of mandrel 22 adjacent to fluid ports 68 in the mandrel. Fluid ports 68 in mandrel 22 are in communication with fluid ports 70 in lower slip housing 58. The lower end of lower slip support 58 is closed below ports 70.

Sliding valve 66 defines a plurality of valve ports 72 which can be aligned with fluid ports 68 in mandrel 22 when sliding valve 66 is in an open position. Thus, fluid can flow through central opening 21.

On the upper end of sliding valve 66 are a plurality of collet fingers 67 which are adapted for latching and unlatching with a valve actuation tool (not shown) of a kind known in the art. This actuation tool is used to open and close sliding valve 66 as further discussed herein. As illustrated in FIG. 2, sliding valve 66 is in a closed position wherein fluid ports 68 are sealed by upper and lower valve seals 74 and 76.

In prior art drillable packers and bridge plugs of this type, mandrel 22 is made of a medium hardness cast iron, and lock ring housing 24, upper slip wedge 32, lower slip wedge 46 and lower slip support 58 are made of soft cast iron for drillability. Most of the other components are made of aluminum, brass or rubber which, of course, are relatively easy to drill. Prior art upper and lower slips 28 and 54 are made of hard cast iron, but are grooved so that they will easily be broken up in small pieces when contacted by the drill bit during a drilling operation.

As previously described, the soft cast iron construction of prior art lock ring housings, upper and lower slip wedges, and lower slip supports are adapted for relatively high pressure and temperature conditions, while a majority of well applications do not require a design for such conditions. Thus, the apparatus of the present invention, which is generally designed for pressures lower than 10,000 psi and temperatures lower than 425° F., utilizes engineering grade plastics for at least some of the components. For example, the apparatus may be designed for pressures up to about 5,000 psi and temperatures up to about 250° F., although the invention is not intended to be limited to these particular conditions.

In first packer embodiment 20, at least some of the previously soft cast iron components of the slip means, such as lock ring housing 24, upper and lower slip wedges 32 and 46 and lower slip support 58 are made of engineering grade plastics. In particular, upper and lower slip wedges 32 and 46 are subjected to substantially compressive loading. Since engineering grade plastics exhibit good strength in compression, they make excellent choices for use in components subjected to compressive loading. Lower slip support 58 is also subjected to substantially compressive loading and can be made of engineering grade plastic when packer 20 is subjected to relative low pressures and temperatures.

Lock ring housing 24 is mostly in compression, but does exhibit some tensile loading. However, in most situations, this tensile loading is minimal, and lock ring housing 24 may also be made of an engineering grade plastic of substantially the same type as upper and lower slip wedges 32 and 46 and also lower slip housing 58.

Upper and lower slips 28 and 54 may also be of plastic in some applications. Hardened inserts for gripping well bore 12 when packer 20 is set may be required as part of the plastic slips. Such construction is discussed in more detail herein for other embodiments of the invention.

Lock ring housing 24, upper slip wedge 32, lower slip wedge 46, and lower slip housing 58 comprise approximately 75% of the cast iron of the prior art squeeze packers. Thus, replacing these components with similar components made of engineering grade plastics will enhance the drillability of packer 20 and reduce the time and cost required therefor.

Mandrel 22 is subjected to tensile loading during setting and operation, and many plastics will not be acceptable materials therefor. However, some engineer-

ing plastics exhibit good tensile loading characteristics, so that construction of mandrel 22 from such plastics is possible. Reinforcements may be provided in the plastic resin as necessary.

EXAMPLE

A first embodiment packer 20 was constructed in which upper slip wedge 32 and lower slip wedge 46 were constructed by molding the parts to size from a phenolic resin plastic with glass reinforcement. The specific material used was Fiberite 4056J manufactured by Fiberite Corporation of Winona, Minn. This material is classified by the manufacturer as a two stage phenolic with glass reinforcement. It has a tensile strength of 18,000 psi and a compressive strength of 40,000 psi.

The test packer 20 held to 8,500 psi without failure to wedges 32 and 46, more than sufficient for most well bore conditions.

Second Packer Embodiment

Referring now to FIGS. 3A and 3B, the details of a second squeeze packer embodiment 100 of packing apparatus 10 are shown. While first embodiment 20 incorporates the same configuration and general components as prior art packers made of metal, second packer embodiment 100 and the other embodiments described herein comprise specific design features to accommodate the benefits and problems of using non-metallic components, such as plastic.

Packer 100 comprises a center mandrel 102 on which most of the other components are mounted. Mandrel 102 may be described as a thick cross-sectional mandrel having a relatively thicker wall thickness than typical packer mandrels, including center mandrel 22 of first embodiment 20. A thick cross-sectional mandrel may be generally defined as one in which the central opening therethrough has a diameter less than about half of the outside diameter of the mandrel. That is, mandrel central opening 104 in central mandrel 102 has a diameter less than about half the outside of center mandrel 102. It is contemplated that a thick cross-sectional mandrel will be required if it is constructed from a material having relatively low physical properties. In particular, such materials may include phenolics and similar plastic materials.

An upper support 106 is attached to the upper end of center mandrel 102 at threaded connection 108. In an alternate embodiment, center mandrel 102 and upper support 106 are integrally formed and there is no threaded connection 108. A spacer ring or upper slip support 110 is disposed on the outside of mandrel 102 just below upper support 106. Spacer ring 110 is initially attached to center mandrel 102 by at least one shear pin 112. A downwardly and inwardly tapered shoulder 114 is defined on the lower side of spacer ring 110.

Disposed below spacer ring 110 are a plurality of upper slips 116. A downwardly and inwardly sloping shoulder 118 forms the upper end of each slip 116. The taper of each shoulder 118 conforms to the taper of shoulder 114 on spacer ring 110, and slips 116 are adapted for sliding engagement with shoulder 114, as will be further described herein.

An upwardly and inwardly facing taper 120 is defined in the lower end of each slip 116. Each taper 120 generally faces the outside of center mandrel 102.

A plurality of hardened inserts or teeth 122 preferably are molded into upper slips 116. In the embodiment shown in FIG. 3A, inserts 122 have a generally square cross section and are positioned at an angle so that a radially outer edge 124 protrudes from the corresponding upper slip 116. Outer edge 124 is adapted for grippingly engaging well bore 112 when packer 100 is set. It is not intended that inserts 122 be of square cross section and have a distinct outer edge 124. Different shapes of inserts may also be used. Inserts 122 can be made of any suitable hardened material.

An upper slip wedge 126 is disposed adjacent to upper slips 116 and engages taper 120 therein. Upper slip wedge 126 is initially attached to center mandrel 102 by one or more shear pins 128.

Below upper slip wedge 126 are upper back-up ring 37, upper packer shoe 38, end packer elements 40 separated by center packer element 42, lower packer shoe 44 and lower back-up ring 45 which are substantially the same as the corresponding components in first embodiment packer 20. Accordingly, the same reference numerals are used.

Below lower back-up ring 45 is a lower slip wedge 130 which is initially attached to center mandrel 102 by a shear pin 132. Preferably, lower slip wedge 130 is identical to upper slip wedge 126 except that it is positioned in the opposite direction.

Lower slip wedge 130 is in engagement with an inner taper 134 in a plurality of lower slips 136. Lower slips 136 have inserts or teeth 138 molded therein, and preferably, lower slips 136 are substantially indentical to upper slips 116.

Each lower slip 136 has a downwardly facing shoulder 140 which tapers upwardly and inwardly. Shoulders 140 are adapted for engagement with a corresponding shoulder 142 defining the upper end of a valve housing 144. Shoulder 142 also tapers upwardly and inwardly. Thus, valve housing 144 may also be considered a lower slip support 144.

Referring now also to FIG. 3B, valve housing 146 is attached to the lower end of center mandrel 102 at threaded connection 146. A sealing means, such as O-ring 148, provides sealing engagement between valve housing 144 and center mandrel 102.

Below the lower end of center mandrel 102, valve housing 104 defines a longitudinal opening 150 therein having a longitudinal rib 152 in the lower end thereof. At the upper end of opening 150 is an annular recess 154.

Below opening 150, valve housing 144 defines a housing central opening including a bore 156 therein having a closed lower end 158. A plurality of transverse ports 160 are defined through valve housing 144 and intersect bore 156. The wall thickness of valve housing 144 is thick enough to accommodate a pair of annular seal grooves 162 defined in bore 156 on opposite sides of ports 160.

Slidably disposed in valve housing 144 below center mandrel 102 is a sliding valve 164. Sliding valve 164 is the same as, or substantially similar to, sliding valve 66 in first embodiment packer 20. At the upper end of sliding valve 164 are a plurality of upwardly extending collet fingers 166 which initially engage recess 154 in valve housing 144. Sliding valve 164 is shown in an uppermost, closed position in FIG. 3B. It will be seen that the lower end of center mandrel 102 prevents further upward movement of sliding valve 164.

Sliding valve 164 defines a valve central opening 168 therethrough which is in communication with central opening 104 in center mandrel 102. A chamfered shoul-

der 170 is located at the upper end of valve central opening 168.

Sliding valve 164 defines a plurality of substantially transverse ports 172 therethrough which intersect valve central opening 168. As will be further discussed herein, ports 172 are adapted for alignment with ports 160 in valve housing 144 when sliding valve 164 is in a downward, open position thereof. Rib 152 fits between a pair of collet fingers 166 so that sliding valve 164 cannot rotate within valve housing 144, thus insuring proper alignment of ports 172 and 160. Rib 152 thus provides an alignment means.

A sealing means, such as O-ring 174, is disposed in each seal groove 162 and provides sealing engagement between sliding valve 164 and valve housing 144. It will thus be seen that when sliding valve 164 is moved downwardly to its open position, O-rings 174 seal on opposite sides of ports 172 in the sliding valve.

Referring again to FIG. 3A, a tension sleeve 174 is disposed in center mandrel 102 and attached thereto to threaded connection 176 Tension sleeve 174 has a threaded portion 178 which extends from center mandrel 102 and is adapted for connection to a standard setting tool (not shown) of a kind known in the art.

Below tension sleeve 174 is an internal seal 180 similar to internal seal 64 in first embodiment 20.

Third Packer Embodiment

Referring now to FIGS. 4A and 4B, a third squeeze packer embodiment of the present invention is shown and generally designated by the numeral 200. It will be clear to those skilled in the art that third embodiment 200 is similar to second packer embodiment 100 but has a couple of significant differences.

Packer 200 comprises a center mandrel 202. Unlike center mandrel 102 in second embodiment 100, center mandrel 202 is a thin cross-sectional mandrel. That is, it may be said that center mandrel 102 has a mandrel central opening 204 with a diameter greater than about half of the outside diameter of center mandrel 202. It is contemplated that thin cross-sectional mandrels, such as center mandrel 202, may be made of materials having relatively higher physical properties, such as epoxy resins.

The external components of third packer embodiment 200 which fit on the outside of center mandrel 202 are substantially identical to the outer components on second embodiment 100, and therefore the same reference numerals are shown in FIG. 4A. In a manner similar to second embodiment packer 100, center mandrel 202 and upper support 106 may be integrally formed so that there is no threaded connection 108.

The lower end of center mandrel 202 is attached to a valve housing 206 at threaded connection 208. On the upper end of valve housing 206 is an upwardly and inwardly tapered shoulder 210 against which shoulder 104 on lower slips 136 are slidably disposed. Thus, valve housing 206 may also be referred to as a lower slip support 206.

Referring now also to FIG. 4B, a sealing means, such as O-ring 212, provides sealing engagement between center mandrel 202 and valve housing 206.

Valve housing 206 defines a housing central opening including a bore 214 therein with a closed lower end 216. At the upper end of bore 214 is an annular recess 218. Valve housing 204 defines a plurality of substantially transverse ports 220 therethrough which intersect bore 214.

Slidably disposed in bore 214 in valve housing 206 is a sliding valve 222. At the upper end of sliding valve 222 are a plurality of collet fingers 224 which initially engage recess 218.

Sliding valve 222 defines a plurality of substantially transverse ports 226 therein which intersect a valve central opening 228 in the sliding valve. Valve central opening 228 is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of central opening 228 is a chamfered shoulder 230.

As shown in FIG. 4B, sliding valve 222 is in an uppermost closed position. It will be seen that the lower end of center mandrel 202 prevents further upward movement of sliding valve 222. When sliding valve 222 is moved downwardly to an open position, ports 226 are substantially aligned with ports 220 in valve housing 206. An alignment means, such as an alignment bolt 232, extends from valve housing 206 inwardly between a pair of adjacent collet fingers 224. A sealing means, such as O-ring 234, provides sealing engagement between alignment bolt 232 and valve housing 206. Alignment bolt 234 prevents rotation of sliding valve 222 within valve housing 204 and insures proper alignment of ports 226 and 220 when sliding valve 222 is in its downwardmost, open position.

The wall thickness of sliding valve 222 is sufficient to accommodate a pair of spaced seal grooves 234 are defined in the outer surface of sliding valve 222, and as seen in FIG. 4B, seal grooves 234 are disposed on opposite sides of ports 220 when sliding valve 222 is in the open position shown. A sealing means, such as seal 236, is disposed in each groove 234 to provide sealing engagement between sliding valve 222 and bore 214 in valve housing 206.

Referring again to FIG. 4A, a tension sleeve 238 is attached to the upper end of center mandrel 202 at threaded connection 240. A threaded portion 242 of tension sleeve 238 extends upwardly from center mandrel 202 and is adapted for engagement with a setting apparatus (not shown) of a kind known in the art.

An internal seal 244 is disposed in the upper end of center mandrel 202 below tension sleeve 238.

Fourth Packer Embodiment

Referring now to FIGS. 5A and 5B, a fourth squeeze packer embodiment is shown and generally designated by the numeral 300. As illustrated, fourth embodiment 300 has the same center mandrel 202, and all of the components positioned on the outside of center mandrel 202 are identical to those in the second and third packer embodiments. Therefore, the same reference numerals are used for these components. Tension sleeve 238 and internal seal 244 positioned on the inside of the upper end of center mandrel 202 are also substantially identical to the corresponding components in third embodiment packer 200 and therefore shown with the same reference numerals.

The difference between fourth packer embodiment 300 and third packer embodiment 200 is that in the fourth embodiment shown in FIGS. 5A and 5B, the lower end of center mandrel 202 is attached to a different valve housing 302 at threaded connection 304. Shoulder 140 on each lower slip 136 slidingly engages an upwardly and inwardly tapered shoulder 306 on the top of valve housing 302. Thus, valve housing 302 may also be referred to as lower slip support 302.

Referring now to FIG. 5B, a sealing means, such as O-ring 308, provides sealing engagement between the lower end of center mandrel 202 and valve housing 302.

Valve housing 302 defines a housing central opening including a bore 310 therein with a closed lower end 312. A bumper seal 314 is disposed adjacent to end 312.

Valve housing 302 defines a plurality of substantially transverse ports 316 therethrough which intersect bore 310. A sliding valve 318 is disposed in bore 310, and is shown in an uppermost, closed position in FIG. 5B. It will be seen that the lower end of center mandrel 202 prevents upward movement of sliding valve 318. Sliding valve 318 defines a valve central opening 320 therethrough which is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of valve central opening 320 in sliding valve 318 is an upwardly facing chamfered shoulder 322.

On the outer surface of sliding valve 318, a pair of spaced seal grooves 324 are defined. In the closed position shown in FIG. 5B, seal grooves 324 are on opposite sides of ports 316 in valve housing 302. A sealing means, such as seal 326, is disposed in each seal groove 324 and provides sealing engagement between sliding valve 318 and bore 310 in valve housing 302.

When sliding valve 318 is opened, as will be further described herein, the sliding valve 318 is moved downwardly such that upper end 328 thereof is below ports 316 in valve housing 302. Downward movement of sliding valve 318 is checked when lower end 330 thereof contacts bumper seal 314. Bumper seal 314 is made of a resilient material which cushions the impact of sliding valve 318 thereon.

Fifth Packer Embodiment

Referring now to FIGS. 6A and 6B, a fifth squeeze packer embodiment is shown and generally designated by the numeral 400. As illustrated, fifth packer embodiment 400 incorporates the same thick cross-sectional center mandrel 102 as does second packer embodiment 100 shown in FIGS. 3A and 3B. Also, the external components positioned on center mandrel 102 are the same as in the second, third and fourth packer embodiments, so the same reference numerals will be used. Further, tension sleeve 174 and internal seal 180 in second embodiment 100 are also incorporated in fifth embodiment 400, and therefore these same reference numerals have also been used.

The difference between fifth packer embodiment 400 and second embodiment 100 is that the lower end of center mandrel 102 is attached to a lower slip support 402 at threaded connection 404. Shoulders 140 on lower slips 136 slidingly engage an upwardly and inwardly tapered shoulder 406 at the upper end of lower slip support 402.

Referring now to FIG. 6B, a sealing means, such as O-ring 408, provides sealing engagement between the lower end of center mandrel 102 and lower slip support 402.

Lower slip support 402 defines a first bore 410 therein and a larger second bore 412 spaced downwardly from the first bore. A tapered seat surface 414 extends between first bore 410 and second bore 412.

The lower end of lower support 402 is attached to a valve housing 416 at threaded connection 418. Valve housing 416 defines a first bore 420 and a smaller second bore 422 therein. An upwardly facing annular shoulder 424 extends between first bore 420 and second bore 422. Below second bore 422, valve housing 416 defines a third bore 426 therein with an internally threaded surface 428 forming a port at the lower end of the valve housing.

Disposed in first bore 420 in valve housing 416 is a valve body 430 with an upwardly facing annular shoulder 432 thereon. An elastomeric valve seal 434 and a valve spacer 436, which provides support for the valve seal, are positioned adjacent to shoulder 432 on valve body 430. A conical valve head 438 is positioned above valve seal 434 and is attached to valve body 430 at threaded connection 440. It will be seen by those skilled in the art that valve seal 434 is adapted for sealing engagement with seat surface 414 in lower slip support 402 when valve body 430 is moved upwardly.

The lower end of valve body 430 is connected to a valve holder 442 by one or more pins 444. Valve holder 442 is disposed in second bore 422 of valve housing 416. A sealing means, such as O-ring 446 provides sealing engagement between valve holder 442 and valve housing 416.

Above shoulder 424 in valve housing 416, valve body 430 has a radially outwardly extending flange 448 thereon. A biasing means, such as spring 450, is disposed between flange 448 and shoulder 424 for biasing valve body 430 upwardly with respect to valve housing 416.

Valve holder 442 defines a first bore 452 and a smaller second bore 454 therein with an upwardly facing chamfered shoulder 456 extending therebetween. A ball 458 is disposed in valve holder 442 and is adapted for engagement with shoulder 456.

First Bridge Plug Embodiment

Referring now to FIG. 7, a first bridge plug embodiment of the present invention is shown and generally designated by the numeral 500. First bridge plug embodiment 500 comprises the same center mandrel 102 and the external components positioned thereon as does the second packer embodiment 100. Therefore, the reference numerals for these components shown in FIG. 7 are the same as in FIG. 3A.

The lower end of center mandrel 102 in first bridge plug embodiment 500 is connected to a lower slip support 502 at threaded connection 504. An upwardly and inwardly tapered shoulder 506 on lower slip support 502 engages shoulders 140 on lower slips 136. As with the other embodiments, slips 136 are adapted for sliding along shoulder 506.

Lower slip support 502 defines a bore 508 therein which is in communication with mandrel central opening 104 in center mandrel 102.

A bridging plug 510 is disposed in the upper portion of mandrel central opening 104 in center mandrel 102 and is sealingly engaged with internal seal 180. A radially outwardly extending flange 512 prevents bridging plug 510 from moving downwardly through center mandrel 102.

Above bridging plug 510 is tension sleeve 174, previously described for second packer embodiment 100.

Second Bridge Plug Embodiment

Referring now to FIG. 8, a second bridge plug embodiment of the present invention is shown and generally designated by the numeral 600. Second bridge plug embodiment 600 uses the same thin cross-sectional mandrel 202 as does third packer embodiment 200 shown in FIG. 4A. Also, the external components positioned on center mandrel 202 are the same as previously de-

scribed, so the same reference numerals are used in FIG. 8.

In second bridge plug embodiment 600, the lower end of center mandrel 202 is attached to the same lower slip support 502 as first bridge plug embodiment 500 at threaded connection 602. It will be seen that bore 508 in lower slip support 502 is in communication with mandrel central opening 204 in center mandrel 202.

A bridging plug 604 is positioned in the upper end of mandrel central opening 204 in center mandrel 202. A shoulder 608 in central opening 204 prevents downward movement of bridging plug 604. A sealing means, such as a plurality of O-rings 606, provide sealing engagement between bridging plug 604 and center mandrel 202.

Tension sleeve 238, previously described, is positioned above bridging plug 604.

Setting And Operation Of The Apparatus

Downhole tool apparatus 10 is positioned in well bore 12 and set into engagement therewith in a manner similar to prior art devices made with metallic components. For example, a prior art apparatus and setting thereof is disclosed in the above-referenced U.S. Pat. No. 4,151,875 to Sullaway. This patent is incorporated herein by reference.

For first packer embodiment 20, the setting tool pulls upwardly on tension sleeve 62, and thereby on mandrel 22, while holding lock ring housing 24. The lock ring housing is thus moved relatively downwardly along mandrel 22 which forces upper slips 28 outwardly and shears screws 34, pushing upper slip wedge 32 downwardly against packer elements 40 and 42. Screws 50 are also sheared and lower slip wedge 46 is pushed downwardly toward lower slip support 58 to force lower slips 54 outwardly. Eventually, upper slips 28 and lower slips 54 are placed in gripping engagement with well bore 12 and packer elements 40 and 42 are in sealing engagement with the well bore. The action of upper slips 28 and 54 prevent packer 20 from being unset. As will be seen by those skilled in the art, pressure below packer 20 cannot force the packer out of well bore 12, but instead, causes it to be even more tightly engaged.

Eventually, in the setting operation, tension sleeve 62 is sheared, so the setting tool may be removed from the well bore.

The setting of second packer embodiment 100, third packer embodiment 200, fourth packer embodiment 300, fifth packer embodiment 400, first bridge plug embodiment 500 and second bridge plug embodiment 600 is similar to that for first packer embodiment 20. The setting tool is attached to either tension sleeve 174 or 238. During setting, the setting tool pushes downwardly on upper slip support 110, thereby shearing shear pin 112. Upper slips 116 are moved downwardly with respect to upper slip wedge 126. Tapers 120 and upper slips 116 slide along upper slip wedge 126, and shoulders 118 on upper slips 116 slide along shoulder 114 on upper slip support 110. Thus, upper slips 116 are moved radially outwardly with respect to center mandrel 102 or 202 such that edges 124 of inserts 122 grippingly well bore 12.

Also during the setting operation, upper slip wedge 126 is forced downwardly, shearing shear pin 128. This in turn causes packer elements 40 and 42 to be squeezed outwardly into sealing engagement with the well bore.

The lifting on center mandrel 102 or 202 causes the lower slip support (valve housing 144 in first packer embodiment 100, valve housing 206 in second packer embodiment 200, valve housing 302 in fourth packer embodiment 300, lower slip support 402 in fifth packer embodiment 400, and lower slip support 502 in first bridge plug embodiment 500 and second bridge plug embodiment 600) to be moved up and lower slips 136 to be moved upwardly with respect to lower slip wedge 130. Tapers 134 in lower slips 136 slide along lower slip wedge 130, and shoulders 140 on lower slips 136 slide along the corresponding shoulder 142, 210, 306, 406, or 506. Thus, lower slips 136 are moved radially outwardly with respect to center mandrel 102 or 202 so that inserts 138 grippingly engage well bore 12.

Also during the setting operation, lower slip wedge 130 is forced upwardly, shearing shear pin 132, to provide additional squeezing force on packer elements 40 and 42.

The engagement of inserts 122 in upper slips 116 and inserts 138 in lower slips 136 with well bore 12 prevent packers 100, 200, 300, 400 and bridge plugs 500, 600 from coming unset.

Once any of packers 20, 100, 200, 300, 400 are set, the valves therein may be actuated in a manner known in the art. Sliding valve 164 in second packer embodiment 126, and sliding valve 22 in third packer embodiment 200 are set in a similar, if not identical manner. Sliding valve 318 in fourth packer embodiment 300 is also set in a similar manner, but does not utilize collets, nor is alignment of sliding valve 318 with respect to ports 316 in valve housing 302 important. Sliding valve 318 is simply moved below ports 316 to open the valve. Bumper seal 314 cushions the downward movement of sliding valve 318, thereby minimizing the possibility of damage to sliding valve 318 or valve housing 302 during an opening operation.

In fifth packer embodiment 400, the valve assembly comprising valve body 432, valve seal 434, valve spacer 436, valve head 438 and valve holder 442 is operated in a manner substantially identical to that of the Halliburton EZ Drill ® squeeze packer of the prior art.

Drilling Out The Packer Apparatus

Drilling out any embodiment of downhole tool 10 may be carried out by using a standard drill bit at the end of tubing string 16. Cable tool drilling may also be used. With a standard "tri-cone" drill bit, the drilling operation is similar to that of the prior art except that variations in rotary speed and bit weight are not critical because the nonmetallic materials are considerably softer than prior art cast iron, thus making tool 10 much easier to drill out. This greatly simplifies the drilling operation and reduces the cost and time thereof.

In addition to standard tri-cone drill bits, and particularly if tool 10 is constructed utilizing engineering grade plastics for the mandrel as well as for slip wedges, slips, slip supports and housings, alternate types of drill bits may be used which would be impossible for tools constructed substantially of cast iron. For example, polycrystalline diamond compact (PDC) bits may be used. Drill bit 14 in FIG. 1 is illustrated as a PDC bit. Such drill bits have the advantage of having no moving parts which can jam up. Also, if the well bore itself was drilled with a PDC bit, it is not necessary to replace it with another or different type bit in order to drill out tool 10.

While specific squeeze packer and bridge plug configurations of packing apparatus 10 has been described herein, it will be understood by those skilled in the art

that other tools may also be constructed utilizing components selected of non-metallic materials, such as engineering grade plastics.

Additionally, components of the various packer embodiments may be interchanged. For example, thick cross-sectional center mandrel 102 may be used with valve housing 206 in second packer embodiment 200 or valve housing 302 in fourth packer embodiment 300. Similarly, thin cross-sectional center mandrel 202 could be used with valve body 144 in second packer embodiment 100 or lower slip support 402 and valve housing 416 in fifth packer embodiment 400. The intent of the invention is to provide devices of flexible design in which a variety of configurations may be used.

It will be seen, therefore, that the downhole tool packer apparatus and methods of drilling thereof of the present invention are well adapted to carry out the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments of the apparatus and various drilling methods have been discussed for the purposes of this disclosure, numerous changes in the arrangement and construction of parts and the steps of the methods may be made by those skilled in the art. In particular, the invention is not intended to be limited to squeeze packers or bridge plugs. All such changes are encompassed within the scope and spirit of the appended claims.

What is claimed is:

1. A well bore process comprising the steps of:

constructing a downhole tool such that a component thereof is made of a non-metallic material, said tool comprising:

a center mandrel; and

a plurality of slips disposed around said mandrel for grippingly engaging a well bore when in a set position;

wherein, at least one of said mandrel and said plurality of slips is said component;

positioning said downhole tool into locking, sealing engagement with said well bore; and

drilling said tool out of said well bore.

2. The process of claim 1 wherein said tool is selected from the group consisting of packers and bridge plugs.

3. The process of claim 1 wherein said component is subject to compressive loading.

4. The process of claim 1 wherein said component is subject to tensile loading.

5. The process of claim 1 wherein said center mandrel defines a central opening therein having a diameter less than about half an outside diameter of said center mandrel.

6. The process of claim 1 wherein said center mandrel defines a central opening therein having a diameter greater than about half the outside diameter of said center mandrel.

7. The process of claim 1 wherein said non-metallic material is plastic.

8. The process of claim 7 wherein said component is molded.

9. The process of claim 7 wherein said plastic is selected from the group consisting of nylon, phenolic material or epoxy resin.

10. The process of claim 9 wherein said plastic is a phenolic material and is selected from the group consisting of Fiberite FM4056J, Fiberite FM4005 or Resinoid 1360.

11. The process of claim 1 wherein said step of drilling is carried out with a polycrystalline diamond compact bit.

12. The process of claim 1 wherein said step of drilling is carried out using a drill bit without substantially varying weight applied to said drill bit.

13. A well bore process comprising the steps of:

positioning and setting a packing device into locked, sealing engagement with a well bore, a portion of said device being made of engineering grade plastic;

contacting said device with well fluids; and

drilling out said device using a polycrystalline diamond compact bit.

14. The process of claim 13 wherein said step of contacting is at a temperature of less than about 250° F.

15. The process of claim 13 wherein said step of contacting is at a pressure of less than about 5,000 psi.

16. The process of claim 13 wherein said portion of said device is at least one of a housing, slip, slip wedge, slip support, and mandrel thereof.

17. The process of claim 13 further comprising the step of, prior to said step of positioning and setting said device, drilling at least a portion of said well bore using a polycrystalline diamond compact bit.

18. The process of claim 13 wherein said step of drilling is carried out without substantially varying weight applied to said bit.

19. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means comprising:

a slip wedge made of a non-metallic material; and

slips made of non-metallic material.

20. The apparatus of claim 19 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

21. The apparatus of claim 20 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means comprising another slip wedge made of a non-metallic material.

22. The apparatus of claim 19 wherein said slip means comprises a slip support made of a non-metallic material.

23. The apparatus of claim 19 further comprising a plurality of hardened inserts molded into said material of said slips.

24. The apparatus of claim 19 wherein said non-metallic material is an engineering grade plastic.

25. The apparatus of claim 24 wherein said plastic is nylon.

26. The apparatus of claim 24 wherein said plastic is a phenolic material.

27. The apparatus of claim 26 wherein said phenolic material is one of Fiberite FM4056J, Fiberite FM4005 and Resinoid 1360.

28. The apparatus of claim 24 wherein said plastic is an epoxy resin.

29. The apparatus of claim 24, wherein said wedge is molded to size.

30. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel made of a non-metallic material; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position.

31. The apparatus of claim 30 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

32. The apparatus of claim 30 wherein said slip means comprises a wedge made of a non-metallic material.

33. The apparatus of claim 30 wherein said slip means comprises slips made of a non-metallic material.

34. The apparatus of claim 30 wherein said non-metallic material is an engineering grade plastic.

35. The apparatus of claim 34 wherein said plastic is nylon.

36. The apparatus of claim 34 wherein said plastic is a phenolic material.

37. The apparatus of claim 36 wherein said phenolic material is Fiberite FM4056J.

38. The apparatus of claim 34 wherein said mandrel is molded to size.

39. The apparatus of claim 34 wherein said mandrel has a central opening defined therethrough having a diameter less than about half an outside diameter of said mandrel.

40. The apparatus of claim 34 wherein said mandrel has a central opening defined therethrough having a diameter greater than about half an outside diameter of said mandrel.

41. The apparatus of claim 34 wherein said plastic is an epoxy resin.

42. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel; and

a plurality of slips disposed around said mandrel for grippingly engaging said well bore when in a set position, said slips being made of a non-metallic material.

43. The apparatus of claim 42 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position; and

wherein some of said slips are disposed above said packing means and some of said slips are disposed below said packing means.

44. The apparatus of claim 42 further comprising a wedge disposed adjacent to said slips, said wedge being made of a non-metallic material.

45. The apparatus of claim 42 wherein said mandrel is made of a non-metallic material.

46. The apparatus of claim 42 wherein said non-metallic material is an engineering grade plastic.

47. The apparatus of claim 46 wherein said plastic material is nylon.

48. The apparatus of claim 46 wherein said plastic is a phenolic material.

49. The apparatus of claim 48 wherein said phenolic material is Fiberite FM4056J.

50. The apparatus of claim 46 wherein said plastic is an epoxy resin.

51. The apparatus of claim 46 wherein said slips are molded of said plastic material.

52. The apparatus of claim 51 further comprising a plurality of hardened inserts molded into said plastic.

53. The apparatus of claim 52 wherein each of said inserts has an edge adapted for grippingly engaging said well bore.

54. A packing apparatus for use in a well bore, said apparatus comprising:

a mandrel made of a non-metallic material;

an upper slip support disposed on said mandrel and made of a non-metallic material;

a plurality of upper slips disposed around said mandrel and substantially made of a non-metallic material;

packing means disposed on said mandrel below said upper slips for sealingly engaging said well bore when in a set position;

a plurality of lower slips disposed around said mandrel below said packing means and substantially made of a non-metallic material; and

a lower slip support attached to said mandrel and made of a non-metallic material.

55. The apparatus of claim 54 wherein said non-metallic material of any of said mandrel, upper slip support, upper slips, lower slips and lower slip support is an engineering grade plastic.

56. The apparatus of claim 55 wherein said plastic is nylon.

57. The apparatus of claim 56 wherein said phenolic material is one of Fiberite FM4056J, Fiberite FM4005 and Resinoid 1360.

58. The apparatus of claim 55 wherein said plastic is a phenolic material.

59. The apparatus of claim 55 wherein said plastic is an epoxy resin.

60. The apparatus of claim 55 wherein any of said mandrel, upper slip support upper slips, lower slips and lower slip support may be molded to size.

61. The apparatus of claim 59 wherein:

said center mandrel defines a mandrel central opening therethrough;

said lower slip support is characterized by a valve housing defining a housing central opening therein and a housing port in communication with said housing central opening; and

further comprising a valve disposed in said housing central opening and providing communication between said port and said mandrel central opening when in an open position, said valve being disposed below a lower end of said mandrel.

62. The apparatus of claim 61 wherein upward movement of said valve is prevented by said mandrel.

63. The apparatus of claim 61 wherein said valve is a sliding valve defining a valve central opening therein and a valve port in communication with said valve central opening, wherein said valve port and said housing port are substantially aligned when said valve is in an open position.

64. The apparatus of claim 63 wherein said valve defines a seal groove therein; and

further comprising sealing means disposed in said seal groove for providing sealing engagement between said valve and said valve housing.

65. The apparatus of claim 63 wherein said valve housing defines a seal groove therein; and

further comprising sealing means disposed in said seal groove for providing sealing engagement between said valve and said valve housing.

66. The apparatus of claim 63 further comprising a bumper seal disposed below said valve for cushioning said valve as said valve is moved to said open position thereof.

67. The apparatus of claim 63 further comprising means for preventing relative rotation between said sliding valve and said valve housing.

68. The apparatus of claim 61 wherein said valve is positioned below said housing port when said valve is in said open position.

69. The apparatus of claim 61 further comprising a poppet type valve disposed in said valve housing for providing communication between said mandrel central opening and said housing port when said valve is in an open position.

70. The apparatus of claim 54 further comprising a bridging plug disposed in said mandrel and sealingly engaged therewith.

71. The apparatus of claim 58 wherein:

said upper slip support has a tapered shoulder on a lower end thereof;

said upper slips have a tapered shoulder on an upper end thereof adapted for sliding engagement with said shoulder on said upper slip support;

said lower slip support has a tapered shoulder on an upper end thereof; and

said lower slips have a tapered shoulder on a lower end thereof adapted for sliding engagement with said shoulder on said lower slip support.

72. The apparatus of claim 54 further comprising a plurality of inserts molded into each of said upper and lower slips, said inserts being made of a hardened material adapted for grippingly engaging said well bore.

73. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel made of a non-metallic material; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means comprising a slip wedge made of a non-metallic material.

74. A downhole apparatus for use in a well bore, said apparatus comprising a slip adapted for grippingly engaging the well bore, said slip being made of a non-metallic, non-elastomeric material.

75. A downhole apparatus for use in a well bore, said apparatus comprising:

a slip adapted for grippingly engaging the well bore, said slip being made of a non-metallic material; and

a hardened insert molded into said slip.

* * * * *

US005224540A

United States Patent [19]

Streich et al.

[11] **Patent Number: 5,224,540**

[45] **Date of Patent: Jul. 6, 1993**

[54] **DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF**

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[73] Assignee: Halliburton Company, Duncan, Okla.

[21] Appl. No.: 883,619

[22] Filed: May 12, 1992

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 719,740, Jun. 21, 1991, which is a continuation-in-part of Ser. No. 515,019, Apr. 26, 1990, abandoned.

[51] Int. Cl.[5] E21B 33/129

[52] U.S. Cl. 166/118; 166/123; 166/128; 166/134; 166/382

[58] Field of Search 166/387, 376, 118, 135, 166/138, 179, 192

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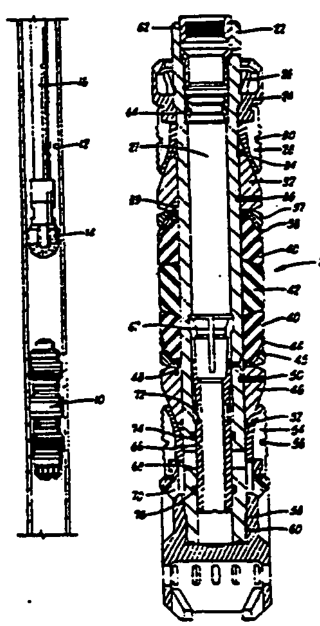
Primary Examiner—Stephen J. Novosad

Attorney, Agent, or Firm—James R. Duzah; Neal R. Kennedy

[57] **ABSTRACT**

A downhole tool apparatus and methods of drilling the apparatus. The apparatus may include, but is not limited to, packers and bridge plugs utilizing non-metallic slip components. The non-metallic material may include engineering grade plastics. In one embodiment, the slips are separate and held in place in an initial position around the slip wedge by a retainer ring. In another embodiment, the slips are integrally formed with a ring portion which holds the slips in the initial position around the wedge; in this embodiment, the ring portion is made of a fracturable non-metallic material which fractures during a setting operation to separate the slips. Methods of drilling out the apparatus without significant variations in the drilling speed and weight applied to the drill bit may be employed. Alternative drill bit types, such as polycrystalline diamond compact (PDC) bits may also be used.

41 Claims, 7 Drawing Sheets



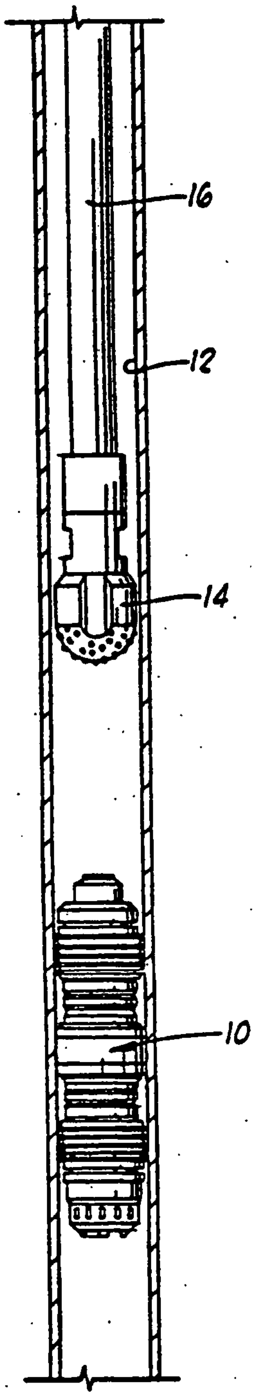

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FIG. 1

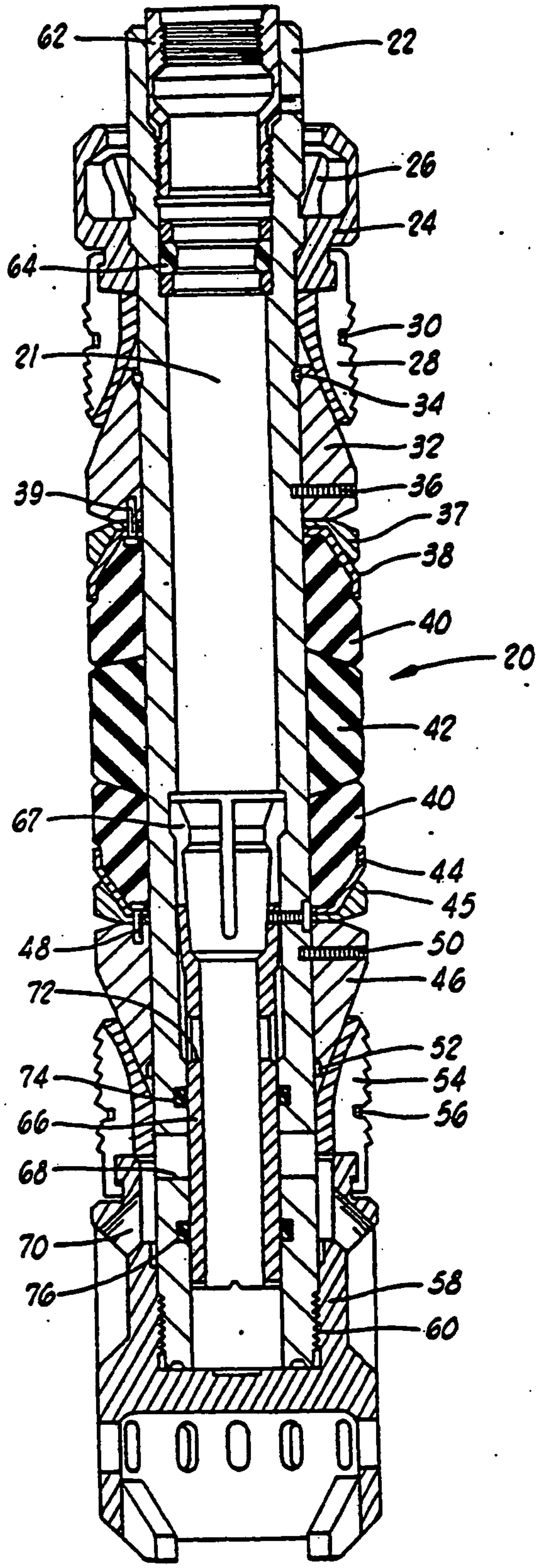
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FIG. 2

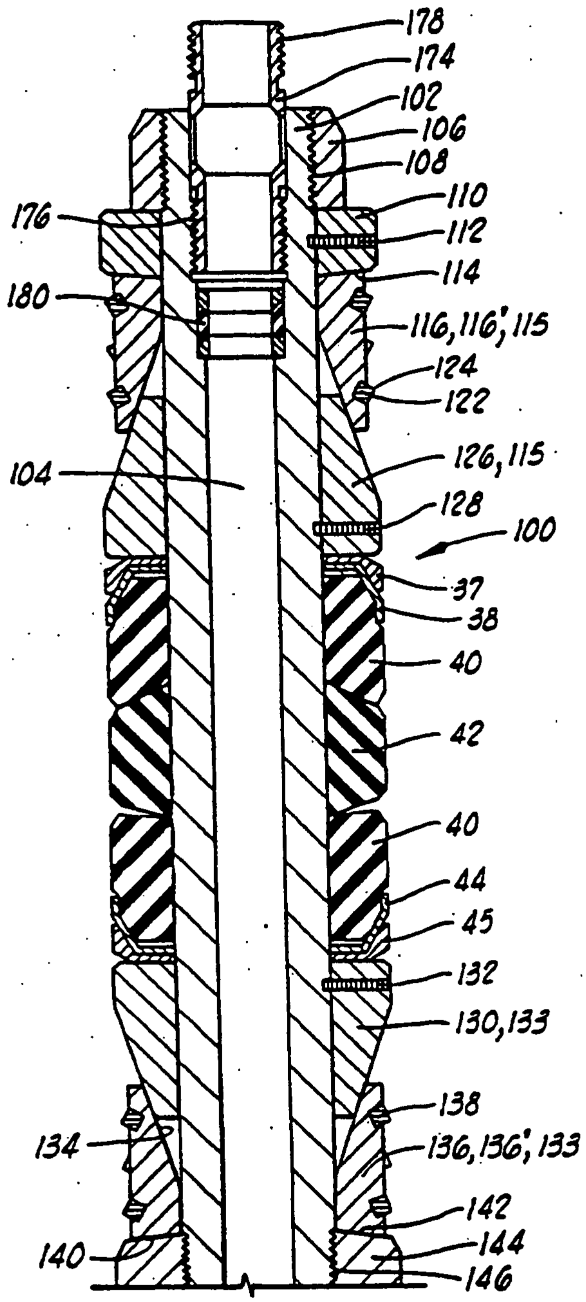
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FIG. 3A

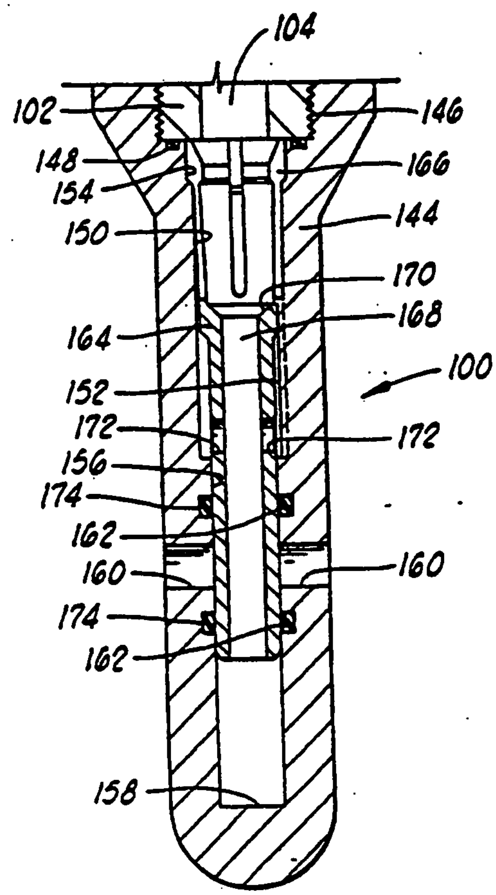
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FIG. 3B

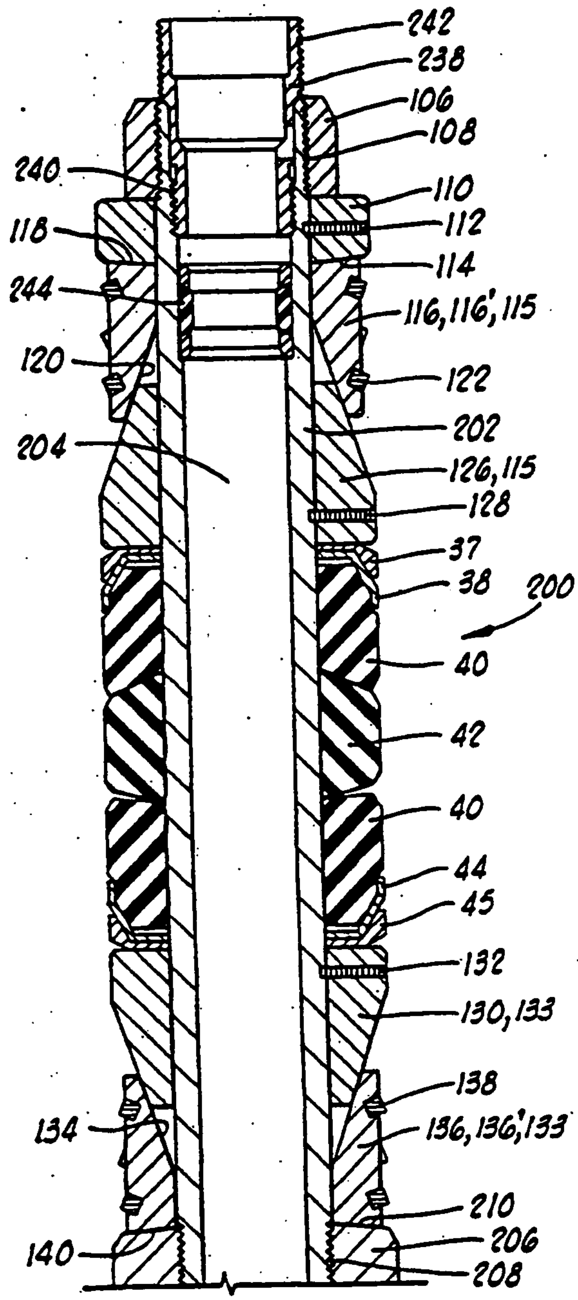
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FIG. 4A

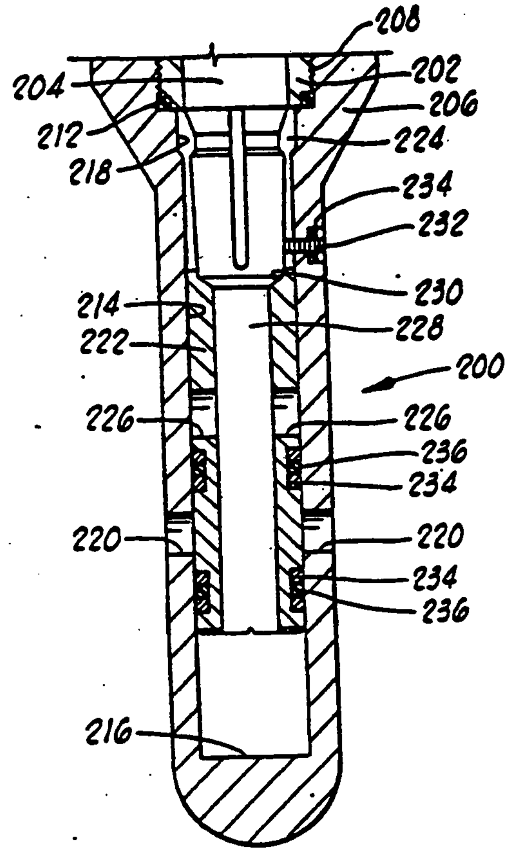
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FIG. 4B

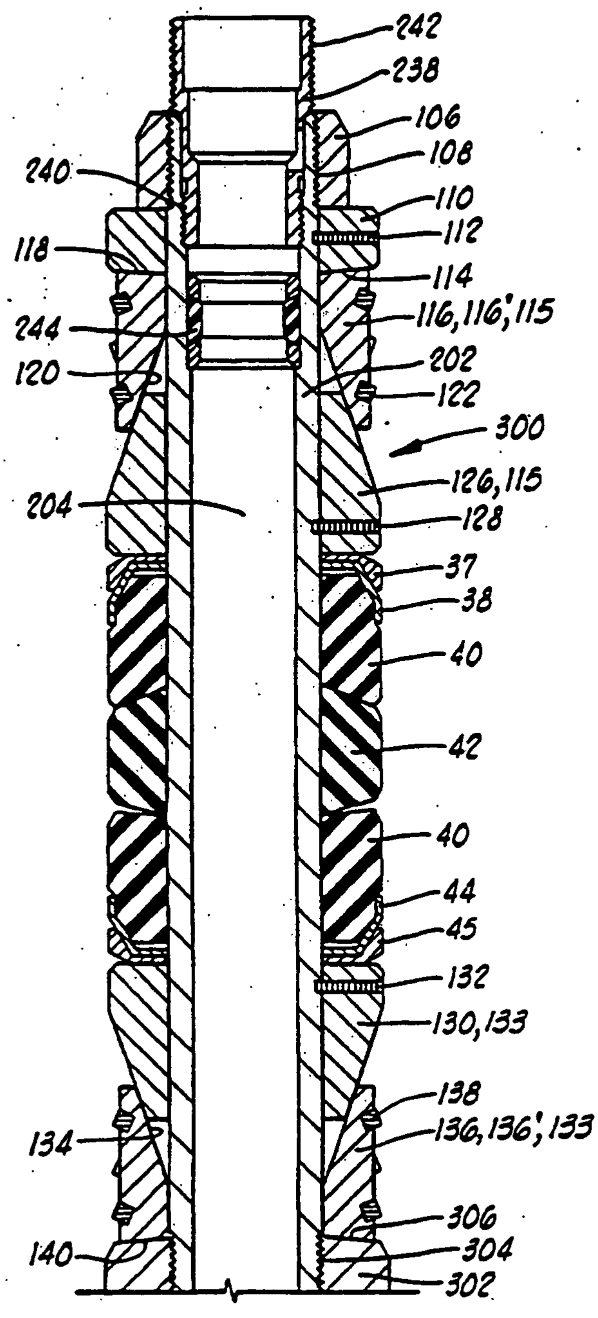
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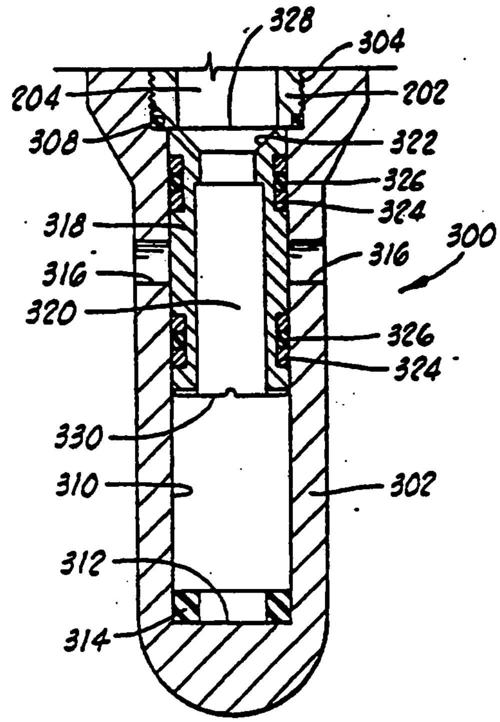
FIG. 5A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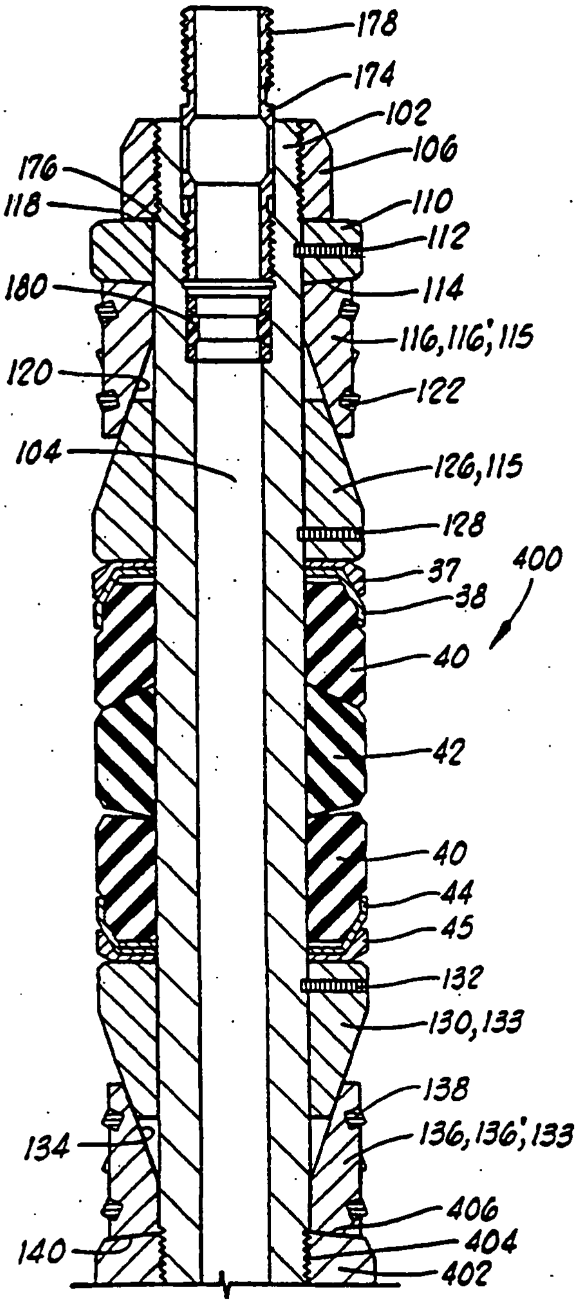
314

FIG. 5B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174
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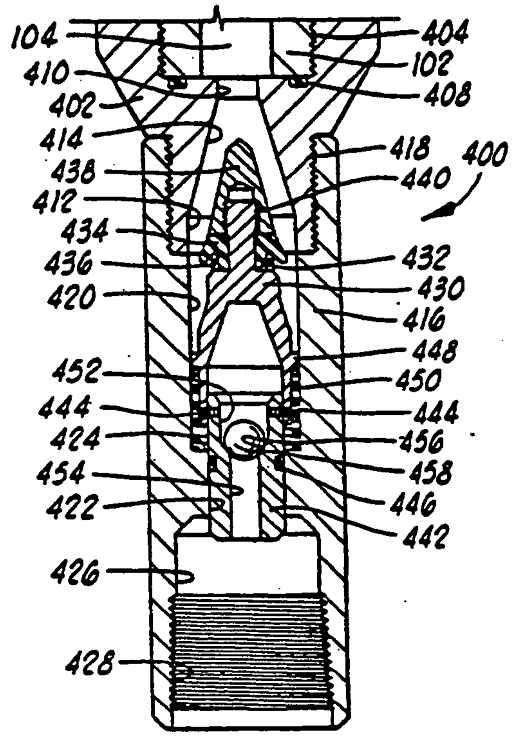
176
118
110
112
180
114
116,116',115
120
122
104
126,115
128
37
38
400
40
42
40
44
45
132
130,133
138
134
136,136',133
406
140
404
402

FIG. 6A


104
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410
102
402
408
414
418
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438
440
412
434
432
436
430
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416
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444
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456
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458
422
446
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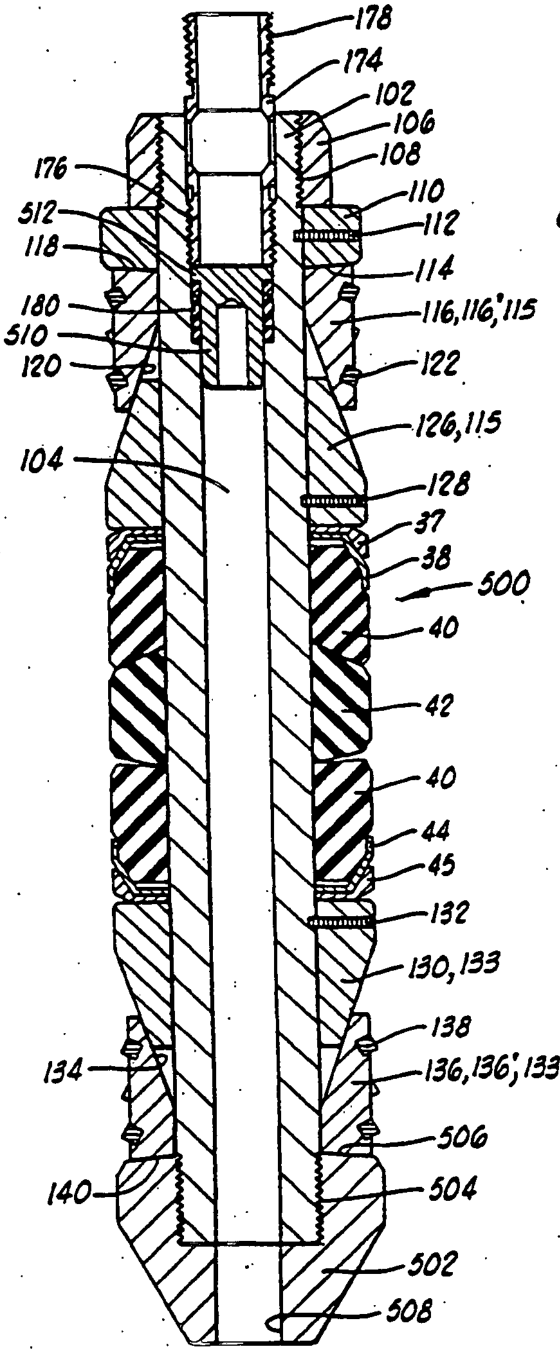
426
428

FIG. 6B


178
174
102
106
108
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110
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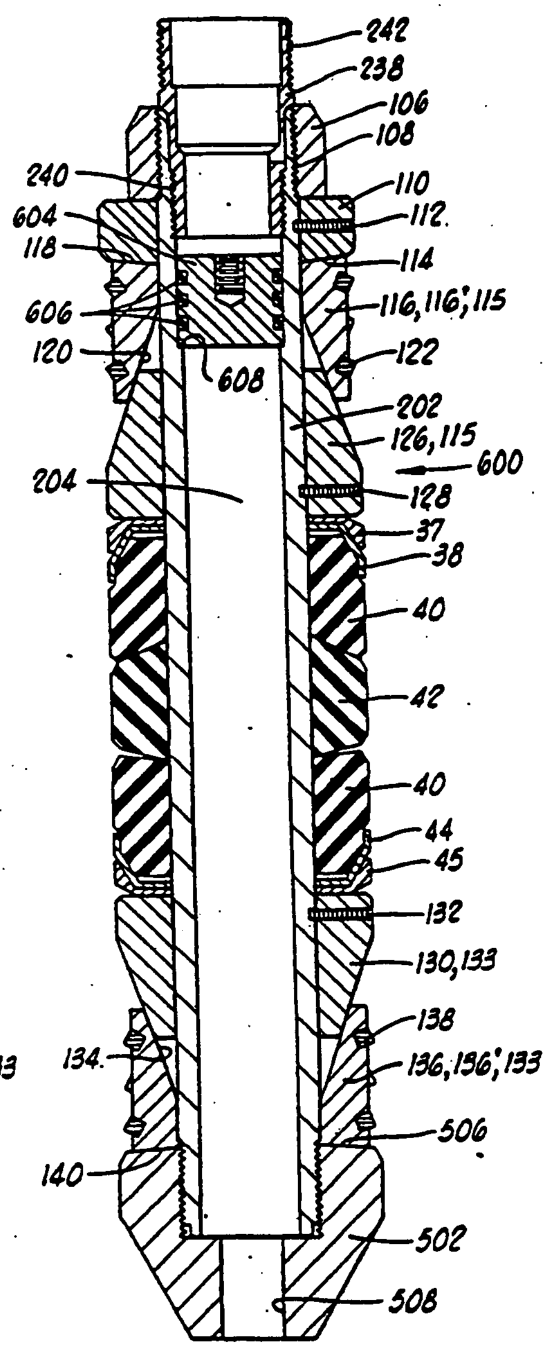
118
114
180
116,116',115
510
120
122
126,115
104
128
37
38
500
40
42
40
44
45
132
130,133
138
134
136,136',133
506
140
504
502
508

FIG. 7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238
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240
110
604
112.
118
114
606
116,116',115
120
122
608
202
126,115
600
204
128
37
38
40
42
40
44
45
132
130,133
138
134.
136,136',133
506
140
502
508

FIG. 8

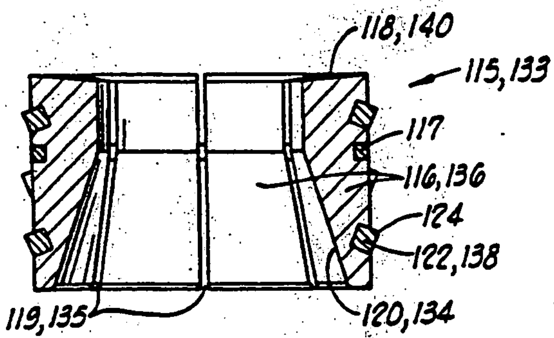

FIG. 9

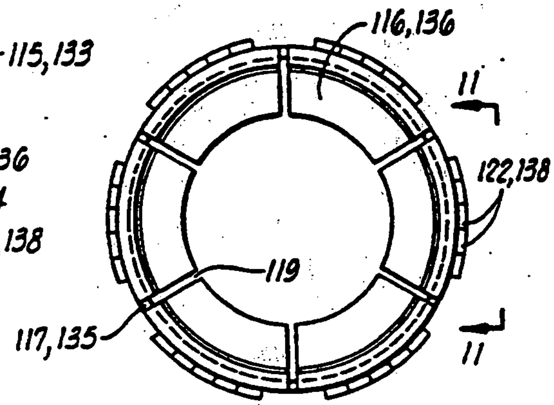

FIG. 10

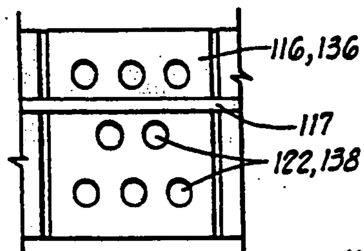

FIG. 11

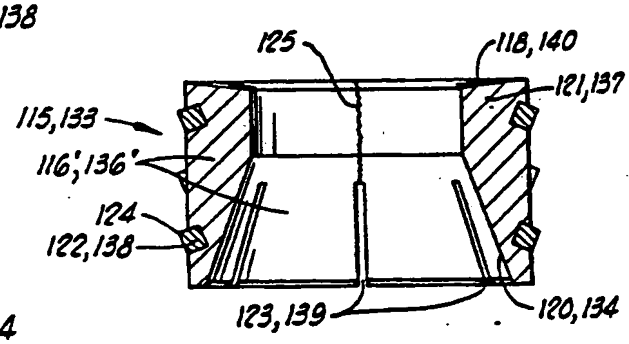

FIG. 12

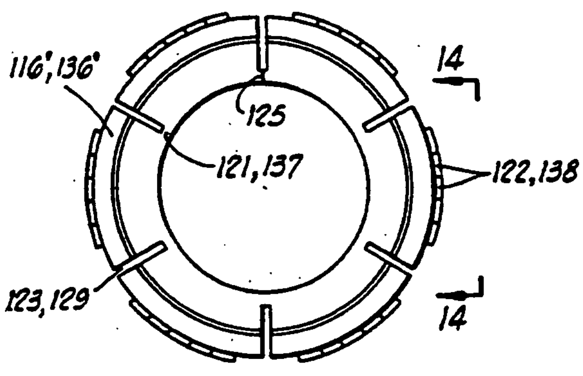

FIG. 13

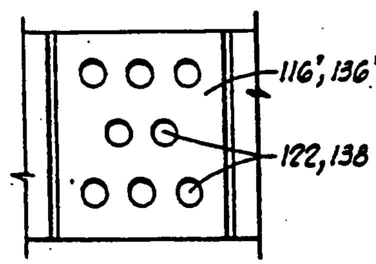

FIG. 14

DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

This application is a continuation-in-part of co-pending application Ser. No. 07/719,740, filed Jun. 21, 1991, which was a continuation-in-part of application Ser. No. 07/515,019, filed Apr. 26, 1990 and now abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to downhole tools for use in well bores and methods of drilling such apparatus out of well bores, and more particularly, to such tools having drillable components, such as slips, therein made at least partially of non-metallic materials, such as engineering grade plastics.

2. Description Of The Prior Art

In the drilling or reworking of oil wells, a great variety of downhole tools are used. For example, but not by way of limitation, it is often desirable to seal tubing or other pipe in the casing of the well, such as when it is desired to pump cement or other slurry down tubing and force the slurry out into a formation. It then becomes necessary to seal the tubing with respect to the well casing and to prevent the fluid pressure of the slurry from lifting the tubing ou of the well. Packers and bridge plugs designed for these general purposes are well known in the art.

When it is desired to remove many of these downhole tools from a well bore, it is frequently simpler and less expensive to mill or drill them out rather than to implement a complex retrieving operation. In milling, a milling cutter is used to grind the packer or plug, for example, or at least the outer components thereof, out of the well bore. Milling is a relatively slow process, but it can be used on packers or bridge plugs having relatively hard components such as erosion-resistant hard steel. One such packer is disclosed in U.S. Pat. No. 4,151,875 to Sullaway, assigned to the assignee of the present invention and sold under the trademark EZ Disposal packer. Other downhole tools in addition to packers and bridge plugs may also be drilled out.

In drilling, a drill bit is used to cut and grind up the components of the downhole tool to remove it from the well bore. This is a much faster operation than milling, but requires the tool to be made out of materials which can be accommodated by the drill bit. Typically, soft and medium hardness cast iron are used on the pressure bearing components, along with some brass and aluminum items. Packers of this type include the Halliburton EZ Drill ® and EZ Drill SV ® squeeze packers.

The EZ Drill SV ® squeeze packer, for example, includes a lock ring housing, upper slip wedge, lower slip wedge, and lower slip support made of soft cast iron. These components are mounted on a mandrel made of medium hardness cast iron. The EZ Drill ® squeeze packer is similarly constructed. The Halliburton EZ Drill ® bridge plug is also similar, except that it does not provide for fluid flow therethrough.

All of the above-mentioned packers are disclosed in Halliburton Services Sales and Service Catalog No. 43, pages 2561-2562, and the bridge plug is disclosed in the same catalog on pages 2556-2557.

The EZ Drill ® packer and bridge plug and the EZ Drill SV ® packer are designed for fast removal from the well bore by either rotary or cable tool drilling methods. Many of the components in these drillable packing devices are locked together to prevent their spinning while being drilled, and the harder slips are grooved so that they will be broken up in small pieces. Typically, standard "tri-cone" rotary drill bits are used which are rotated at speeds of about 75 to about 120 rpm. A load of about 5,000 to about 7,000 pounds of weight is applied to the bit for initial drilling and increased as necessary to drill out the remainder of the packer or bridge plug, depending upon its size. Drill collars may be used as required for weight and bit stabilization.

Such drillable devices have worked well and provide improved operating performance at relatively high temperature and pressures. The packers and plug mentioned above are designed to withstand pressures of about 10,000 psi and temperatures of about 425° F. after being set in the well bore. Such pressures and temperatures require the cast iron components previously discussed.

However, drilling out iron components requires certain techniques. Ideally, the operator employs variations in rotary speed and bit weight to help break up the metal parts and reestablish bit penetration should bit penetration cease while drilling. A phenomenon known as "bit tracking" can occur, wherein the drill bit stays on one path and no longer cuts into the downhole tool. When this happens, it is necessary to pick up the bit above the drilling surface and rapidly recontact the bit with the packer or plug and apply weight while continuing rotation. This aids in breaking up the established bit pattern and helps to reestablish bit penetration. If this procedure is used, there are rarely problems. However, operators may not apply these techniques or even recognize when bit tracking has occurred. The result is that drilling times are greatly increased because the bit merely wears against the surface of the downhole tool rather than cutting into it to break it up.

While cast iron components may be necessary for the high pressures and temperatures for which they are designed, it has been determined that many wells experience pressures less than 10,000 psi and temperatures less than 425° F. This includes most wells cemented. In fact, in the majority of wells, the pressure is less than about 5,000 psi, and the temperature is less than about 250° F. Thus, the heavy duty metal construction of the previous downhole tools, such as the packers and bridge plugs described above, is not necessary for many applications, and if cast iron components can be eliminated or minimized the potential drilling problems resulting from bit tracking might be avoided as well.

The downhole tool of the present invention solves this problem by providing an apparatus wherein at least some of the components, including slips and pressure bearing components, are made at least partially of non-metallic materials, such as engineering grade plastics. Such plastic components are much more easily drilled than cast iron, and new drilling methods may be employed which use alternative drill bits such as polycrystalline diamond compact bits, or the like, rather than standard tri-cone bits.

SUMMARY OF THE INVENTION

The downhole tool apparatus of the present invention utilizes non-metallic materials, such as engineering grade plastics, to reduce weight, to reduce manufacturing time and labor, to improve performance through

reducing frictional forces of sliding surfaces, to reduce costs and to improve drillability of the apparatus when drilling is required to remove the apparatus from the well bore. Primarily, in this disclosure, the downhole tool is characterized by well bore packing apparatus, but it is not intended that the invention be limited to such packing devices. The non-metallic components in the downhole tool apparatus also allow the use of alternative drilling techniques to those previously known.

In packing apparatus embodiments of the present invention, the apparatus may utilize the same general geometric configuration of previously known drillable packers and bridge plugs while replacing at least some of the metal components with non-metallic materials which can still withstand the pressures and temperatures exposed thereto in many well bore applications. In other embodiments of the present invention, the apparatus may comprise specific design changes to accommodate the advantages of plastic materials and also to allow for the reduced strengths thereof compared to metal components.

In one embodiment of the downhole tool, the invention comprises a center mandrel and slip means disposed on the mandrel for grippingly engaging the well bore when in a set position. In packing embodiments, the apparatus further comprises a packing means disposed on the mandrel for sealingly engaging the well bore when in a set position.

The slips means comprises a slip wedge positioned around the center mandrel, a plurality of slips disposed in an initial position around the mandrel and adjacent to the wedge, retaining means for holding the slips in the initial position, and a slip support on an opposite side of the slips from the wedge. In one embodiment, the slips are separate and the retaining means is characterized by a retaining band extending at least partially around the slips. In another embodiment, the retaining means is characterized by a ring portion integrally formed with the slips. This ring portion is fracturable during a setting operation, whereby the slips are separated so that they can be moved into gripping engagement with the well bore. Hardened inserts may be molded into the slips of either embodiment. The inserts may be metallic, such as hardened steel, or non-metallic, such as ceramic.

Any of the mandrel, slips, slip wedges or slip supports may be made of the non-metallic material, such as plastic. Specific plastics include nylon, phenolic materials and epoxy resins. The phenolic materials may further include any of Fiberite FM4056J, Fiberite FM4005 or Resinoid 1360. The plastic components may be molded or machined.

One preferred plastic material for at least some of these components is a glass reinforced phenolic resin having a tensile strength of about 18,000 psi and a compressive strength of about 40,000 psi, although the invention is not intended to be limited to this particular plastic or a plastic having these specific physical properties. The plastic materials are preferably selected such that the packing apparatus can withstand well pressures less than about 10,000 psi and temperatures less than about 425° F. In one preferred embodiment, but not by way of limitation, the plastic materials of the packing apparatus are selected such that the apparatus can withstand well pressures up to about 5,000 psi and temperatures up to about 250° F.

Most of the components of the slip means are subjected to substantially compressive loading when in a sealed operating position in the well bore, although

some tensile loading may also be experienced. The center mandrel typically ha tensile loading applied thereto when setting the packer and when the packer is in its operating position.

One new method of the invention is a well bore process comprising the steps of positioning a downhole tool into engagement with the well bore; prior to the step of positioning, constructing the tool such that a component thereof is made of a non-metallic material; and then drilling the tool out of the well bore. The tool may be selected from the group consisting packers and bridge plugs, but is not limited to these devices.

The component made of non-metallic material, may be one of several such components. The components may be substantially subject to compressive loading. Such components in the tool may include lock ring housings, slips, slip wedges and slip supports. Some components, such as center mandrels of such tools may be substantially subjected to tensile loading.

In another embodiment, the step of drilling is carried out using a polycrystalline diamond compact bit. Regardless of the type of drill bit used, the process may further comprise the step of drilling using a drill bit without substantially varying the weight applied to the drill bit.

In another method of the invention, a well bore process comprises the steps of positioning and setting a packing device in the well bore, a portion of the device being made of engineering grade plastic; contacting the device with well fluids; and drilling out the device using a drill bit having no moving parts such as a polycrystalline diamond compact bit. This or a similar drill bit might have been previously used in drilling the well bore itself, so the process may be said to further comprise the step of, prior to the step of positioning and setting the packer, drilling at least a portion of the well bore using a drill bit such as a polycrystalline diamond compact bit.

In one preferred embodiment, the step of contacting the packer is at a pressure of less than about 5,000 psi and a temperature of less than about 250° F, although higher pressures and temperatures may also be encountered.

It is an important object of the invention to provide a downhole tool apparatus utilizing components, such as slip means, made at least partially of non-metallic materials and methods of drilling thereof.

It is another object of the invention to provide a well bore packing apparatus using slip means components made of engineering grade plastic.

It is a further object of the invention to provide a packing apparatus which may be drilled by alternate methods to those using standard rotary drill bits.

Additional objects and advantages of the invention will become apparent as the following detailed description of the preferred embodiments is read in conjunction with the drawings which illustrate such preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 generally illustrates the downhole tool of the present invention positioned in a well bore with a drill bit disposed thereabove.

FIG. 2 illustrates a cross section of one embodiment of a drillable packer made in accordance with the invention.

FIGS. 3A and 3B show a cross section of a second embodiment of a drillable packer.

FIGS. 4A and 4B show a third drillable packer embodiment.

FIGS. 5A and 5B illustrate a fourth embodiment of a drillable packer.

FIGS. 6A and 6B show a fifth drillable packer embodiment with a poppet valve therein.

FIG. 7 shows a cross section of one embodiment of a drillable bridge plug made in accordance with the present invention.

FIG. 8 illustrates a second embodiment of a drillable bridge plug.

FIG. 9 is a vertical cross section of one preferred embodiment of slips used in the drillable packer and bridge plug of the plug of the present invention.

FIG. 10 is an end view of the slips shown in FIG. 9.

FIG. 11 is an elevational view taken along lines 11—11 in FIG. 10.

FIG. 12 shows a vertical cross section of an alternate embodiment of slips used in the drillable packer and bridge plug of the present invention.

FIG. 13 is an end view of the slips of FIG. 12.

FIG. 14 shows an elevation as seen along lines 14—14 in FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to FIG. 1, the downhole tool apparatus of the present invention is shown and generally designated by the numeral 10. Apparatus 10, which may include, but is not limited to, packers, bridge plugs, or similar devices, is shown in an operating position in a well bore 12. Apparatus 10 can be set in this position by any manner known in the art such as setting on a tubing string or wire line. A drill bit 14 connected to the end of a tool or tubing string 16 is shown above apparatus 10 in a position to commence the drilling out of apparatus 10 from well bore 12. Methods of drilling will be further discussed herein.

First Packer Embodiment

Referring now to FIG. 2, the details of a first squeeze packer embodiment 20 of apparatus 10 will be described. The size and configuration of packer 20 is substantially the same as the previously mentioned prior art EZ Drill SV® squeeze packer. Packer 20 defines a generally central opening 21 therein.

Packer 20 comprises a center mandrel 22 on which most of the other components are mounted. A lock ring housing 24 is disposed around an upper end of mandrel 22 and generally encloses a lock ring 26.

Disposed below lock ring housing 24 and pivotally connected thereto are a plurality of upper slips 28 initially held in place by a retaining means, such as retaining band or ring 30. A generally conical upper slip wedge is disposed around mandrel 22 adjacent to upper slips 30. Upper slip wedge 32 is held in place on mandrel 22 by a wedge retaining ring 34 and a plurality of screws 36.

Adjacent to the lower end of upper slip wedge 32 is an upper back-up ring 37 and an upper packer shoe 38 connected to the upper slip wedge by a pin 39. Below upper packer shoe 38 are a pair of end packer elements 40 separated by center packer element 42. A lower packer shoe 44 and lower back-up ring 45 are disposed adjacent to the lowermost end packer element 40.

A generally conical lower slip wedge 46 is positioned around mandrel 22 adjacent to lower packer shoe 44, and a pin 48 connects the lower packer shoe to the lower slip wedge.

Lower slip wedge 46 is initially attached to mandrel 22 by a plurality of screws 50 and a wedge retaining ring 52 in a manner similar to that for upper slip wedge 32. A plurality of lower slips 54 are disposed adjacent to lower slip wedge 46 and are initially held in place by a retaining means, such as retaining band or ring 56. Lower slips 54 are pivotally connected to the upper end of a lower slip support 58. Mandrel 22 is attached to lower slip support 58 at threaded connection 60.

Disposed in mandrel 22 at the upper end thereof is a tension sleeve 62 below which is an internal seal 64. Tension sleeve 62 is adapted for connection with a setting tool (not shown) of a kind known in the art.

A collet-latch sliding valve 66 is slidably disposed in central opening 21 at the lower end of mandrel 22 adjacent to fluid ports 68 in the mandrel. Fluid ports 68 in mandrel 22 are in communication with fluid ports 70 in lower slip housing 58. The lower end of lower slip support 58 is closed below ports 70.

Sliding valve 66 defines a plurality of valve ports 72 which can be aligned with fluid ports 68 in mandrel 22 when sliding valve 66 is in an open position. Thus, fluid can flow through central opening 21.

On the upper end of sliding valve 66 are a plurality of collet fingers 67 which are adapted for latching and unlatching with a valve actuation tool (not shown) of a kind known in the art. This actuation tool is used to open and close sliding valve 66 as further discussed herein. As illustrated in FIG. 2, sliding valve 66 is in a closed position wherein fluid ports 68 are sealed by upper and lower valve seals 74 and 76.

In prior art drillable packers and bridge plugs of this type, mandrel 22 is made of a medium hardness cast iron, and lock ring housing 24, upper slip wedge 32, lower slip wedge 46 and lower slip support 58 are made of soft cast iron for drillability. Most of the other components are made of aluminum, brass or rubber which, of course, are relatively easy to drill. Prior art upper and lower slips 28 and 54 are made of hard cast iron, but are grooved so that they will easily be broken up in small pieces when contacted by the drill bit during a drilling operation.

As previously described, the soft cast iron construction of prior art lock ring housings, upper and lower slip wedges, and lower slip supports are adapted for relatively high pressure and temperature conditions, while a majority of well applications do not require a design for such conditions. Thus, the apparatus of the present invention, which is generally designed for pressures lower than 10,000 psi and temperatures lower than 425° F., utilizes engineering grade plastics for at least some of the components. For example, the apparatus may be designed for pressures up to about 5,000 psi and temperatures up to about 250° F., although the invention is not intended to be limited to these particular conditions.

In first packer embodiment 20, at least some of the previously soft cast iron components of the slip means, such as lock ring housing 24, upper and lower slip wedges 32 and 46 and lower slip support 58 are made of engineering grade plastics. In particular, upper and lower slip wedges 32 and 46 are subjected to substantially compressive loading. Since engineering grade plastics exhibit good strength in compression, they make excellent choices for use in components subjected to compressive loading. Lower slip support 58 is also subjected to substantially compressive loading and can

be made of engineering grade plastic when packer 20 is subjected to relative low pressures and temperatures.

Lock ring housing 24 is mostly in compression, but does exhibit some tensile loading. However, in most situations, this tensile loading is minimal, and lock ring housing 24 may also be made of an engineering grade plastic of substantially the same type as upper and lower slip wedges 32 and 46 and also lower slip housing 58.

Upper and lower slips 28 and 54 are illustrated in FIG. 2 as having a conventional configuration. However, non-metallic materials may be used, and thus upper and lower slips 28 and 54 may be made of plastic, for example, in some applications. Hardened inserts for gripping well bore 12 when packer 20 is set may be required as part of the plastic slips. New embodiments of slips utilizing such non-metallic materials will be described later herein.

Lock ring housing 24, upper slip wedge 32, lower slip wedge 46, and lower slip housing 58 comprise approximately 75% of the cast iron of the prior art squeeze packers. Thus, replacing these components with similar components made of engineering grade plastics will enhance the drillability of packer 20 and reduce the time and cost required therefor.

Mandrel 22 is subjected to tensile loading during setting and operation, and many plastics will not be acceptable materials therefor. However, some engineering plastics exhibit good tensile loading characteristics, so that construction of mandrel 22 from such plastics is possible. Reinforcements may be provided in the plastic resin as necessary.

Example

A first embodiment packer 20 was constructed in which upper slip wedge 32 and lower slip wedge 46 were constructed by molding the parts to size from a phenolic resin plastic with glass reinforcement. The specific material used was Fiberite 4056J manufactured by Fiberite Corporation of Winona, Minn. This material is classified by the manufacturer as a two stage phenolic with glass reinforcement. It has a tensile strength of 18,000 psi and a compressive strength of 40,000 psi.

The test packer 20 held to 8,500 psi without failure to wedges 32 and 46, more than sufficient for most well bore conditions.

Second Packer Embodiment

Referring now to FIGS. 3A and 3B, the details of a second squeeze packer embodiment 100 of packing apparatus 10 are shown. While first embodiment 20 incorporates the same configuration and general components as prior art packers made of metal, second packer embodiment 100 and the other embodiments described herein comprise specific design features to accommodate the benefits and problems of using non-metallic components, such as plastic.

Packer 100 comprises a center mandrel 102 on which most of the other components are mounted. Mandrel 102 may be described as a thick cross-sectional mandrel having a relatively thicker wall thickness than typical packer mandrels, including center mandrel 22 of first embodiment 20. A thick cross-sectional mandrel may be generally defined as one in which the central opening therethrough has a diameter less than about half of the outside diameter of the mandrel. That is, mandrel central opening 104 in central mandrel 102 has a diameter less than about half the outside of center mandrel 102. It is contemplated that a thick cross-sectional mandrel will be required if it is constructed from a material having relatively low physical properties. In particular, such materials may include phenolics and similar plastic materials.

An upper support 106 is attached to the upper end of center mandrel 102 at threaded connection 108. In an alternate embodiment, center mandrel 102 and upper support 106 are integrally formed and there is no threaded connection 108. A spacer ring or upper slip support 110 is disposed on the outside of mandrel 102 just below upper support 106. Spacer ring 110 is initially attached to center mandrel 102 by at least one shear pin 112. A downwardly and inwardly tapered shoulder 114 is defined on the lower side of spacer ring 110.

Disposed below spacer ring 110 is an upper slip means 115 comprising slips and a wedge. Referring now to FIGS. 9–11, a new embodiment of upper slip means 115 is characterized as comprising a plurality of separate non-metallic upper slips 116 held in place by a retaining means, such as retaining band or ring 117 extending at least partially around slips 116. Upper slips 116 may be held in place by other types of retaining means as well, such as pins. Slips 116 are preferably circumferentially spaced such that a longitudinally extending gap 119 is defined therebetween.

Each slip 116 has a downwardly and inwardly sloping shoulder 118 forming the upper end thereof. The taper of each shoulder 118 conforms to the taper of shoulder 114 on spacer ring 110, and slips 116 are adapted for sliding engagement with shoulder 114, as will be further described herein.

An upwardly and inwardly facing taper 120 is defined in the lower end of each slip 116. Each taper 120 generally faces the outside of center mandrel 102.

Referring now to FIGS. 12–14, an alternate embodiment of the slips of upper slip means 115 is shown. In this embodiment, a plurality of upper slips 116, are integrally formed at the upper ends thereof such that a ring portion 121 is formed. Ring portion 121 may be considered a retaining means for holding upper slips 116' in their initial position around center mandrel 102. The lower ends of slips 116' extend from ring portion 121 and are circumferentially separated by a plurality of longitudinally extending gaps 123. That is, in the second embodiment upper slip means 115 is a characterized as comprising a single piece molded or otherwise formed from a non-metallic material, such as plastic.

Each slip 116', like each slip 116, has downwardly and inwardly sloping shoulder 118 forming the upper end thereof and generally defined in ring portion 121. Again, the taper of each shoulder 118 conforms to the taper of shoulder 114 on spacer ring 110, and slips 116' are adapted for sliding engagement with shoulder 114, as will be further described herein.

As with slips 116, an upwardly and inwardly facing taper 120 is defined in the lower end of each slip 116'. As before, each taper 120 generally faces the outside of center mandrel 102.

A plurality of inserts or teeth 122 preferably are molded into upper slips 116 or 116'. Inserts 122 may have a generally cylindrical configuration and are positioned at an angle with respect to a central axis of packer 100. Thus, a radially outer edge 124 of each insert 122 protrudes from the corresponding upper slip 116 or 116'. Outer edge 124 is adapted for grippingly engaging well bore 12 when packer 100 is set. It is not intended that inserts 122 be limited to this cylindrical

shape or that they have a distinct outer edge 124. Various shapes of inserts may be used.

Inserts 122 can be made of any suitable hard material. For example, inserts 122 could be hardened steel or a non-metallic hardened material, such as ceramic.

Upper slip means 115 further comprises an upper slip wedge 126 which is disposed adjacent to upper slips 116 or 116' and engages taper 120 therein. Upper slip wedge 126 is initially attached to center mandrel 102 by one or more shear pins 128.

Below upper slip wedge 126 are upper back-up ring 37, upper packer shoe 38, end packer elements 40 separated by center packer element 42, lower packer shoe 44 and lower back-up ring 45 which are substantially the same as the corresponding components in first embodiment packer 20. Accordingly, the same reference numerals are used.

Below lower back-up ring 45 is a lower slip means 133 comprising a lower slip wedge 130 which is initially attached to center mandrel 102 by a shear pin 132. Preferably, lower slip wedge 130 is identical to upper slip wedge 126 except that it is positioned in the opposite direction.

In one new embodiment, lower slip means 133 is characterized as also comprising a plurality of separate non-metallic lower slips 136. Lower slips 136 are preferably identical to upper slips 116, except for a reversal of position, and are initially held in place by retaining means, such as retainer band or ring 117 which extends at least partially around slips 136. Other types of retainer means, such as pins, may also be used to hold slip lower slips 136 in place. Lower slips are preferably circumferentially spaced such that longitudinally extending gaps 135 are defined therebetween. See FIGS. 9–11.

In another embodiment, lower slip means 133 comprises a plurality of lower slips 136' which are integrally formed at the lower ends thereof such that a ring portion 137 is formed. Ring portion 137 may be considered a retaining means for holding lower slips 136' in their initial position around center mandrel 102. It will be seen that lower slips 136' are preferably identical to upper slips 116', except for a reversal in position. See FIGS. 12–14. At the upper ends thereof, slips 136' are circumferentially separated by plurality of longitudinally extending gaps 139.

A downwardly and inwardly facing inner taper 134 in each lower slip 136 or 136' is in engagement with lower slip wedge 130.

Lower slips 136 or 136' have inserts or teeth 138 molded therein which are preferably identical to inserts 122 in upper slips 116 or 116'.

Each lower slip 136 or 136' has a downwardly facing shoulder 140 defined in ring portion 137 which tapers upwardly and inwardly. Shoulders 140 are adapted for engagement with a corresponding shoulder 142 defining the upper end of a valve housing 144. Shoulder 142 also tapers upwardly and inwardly. Thus, valve housing 144 may also be considered a lower slip support 144.

Referring now also to FIG. 3B, valve housing 146 is attached to the lower end of center mandrel 102 at threaded connection 146. A sealing means, such as O-ring 148, provides sealing engagement between valve housing 144 and center mandrel 102.

Below the lower end of center mandrel 102, valve housing 104 defines a longitudinal opening 150 therein having a longitudinal rib 152 in the lower end thereof. At the upper end of opening 150 is an annular recess 154.

Below opening 150, valve housing 144 defines a housing central opening including a bore 156 therein having a closed lower end 158. A plurality of transverse ports 160 are defined through valve housing 144 and intersect bore 156. The wall thickness of valve housing 144 is thick enough to accommodate a pair of annular seal grooves 162 defined in bore 156 on opposite sides of ports 160.

Slidably disposed in valve housing 144 below center mandrel 102 is a sliding valve 164. Sliding valve 164 is the same as, or substantially similar to, sliding valve 66 in first embodiment packer 20. At the upper end of sliding valve 164 are a plurality of upwardly extending collet fingers 166 which initially engage recess 154 in valve housing 144. Sliding valve 164 is shown in an uppermost, closed position in FIG. 3B. It will be seen that the lower end of center mandrel 102 prevents further upward movement of sliding valve 164.

Sliding valve 164 defines a valve central opening 168 therethrough which is in communication with central opening 104 in center mandrel 102. A chamfered shoulder 170 is located at the upper end of valve central opening 168.

Sliding valve 164 defines a plurality of substantially transverse ports 172 therethrough which intersect valve central opening 168. As will be further discussed herein, ports 172 are adapted for alignment with ports 160 in valve housing 144 when sliding valve 164 is in a downward, open position thereof. Rib 152 fits between a pair of collet fingers 166 so that sliding valve 164 cannot rotate within valve housing 144, thus insuring proper alignment of ports 172 and 160. Rib 152 thus provides an alignment means.

A sealing means, such as O-ring 174, is disposed in each seal groove 162 and provides sealing engagement between sliding valve 164 and valve housing 144. It will thus be seen that when sliding valve 164 is moved downwardly to its open position, O-rings 174 seal on opposite sides of ports 172 in the sliding valve.

Referring again to FIG. 3A, a tension sleeve 174 is disposed in center mandrel 102 and attached thereto to threaded connection 176. Tension sleeve 174 has a threaded portion 178 which extends from center mandrel 102 and is adapted for connection to a standard setting tool (not shown) of a kind known in the art.

Below tension sleeve 174 is an internal seal 180 similar to internal seal 64 in first embodiment 20.

Third Packer Embodiment

Referring now to FIGS. 4A and 4B, a third squeeze packer embodiment of the present invention is shown and generally designated by the numeral 200. It will be clear to those skilled in the art that third embodiment 200 is similar to second packer embodiment 100 but has a couple of significant differences.

Packer 200 comprises a center mandrel 202. Unlike center mandrel 102 in second embodiment 100, center mandrel 202 is a thin cross-sectional mandrel. That is, it may be said that center mandrel 102 has a mandrel central opening 204 with a diameter greater than about half of the outside diameter of center mandrel 202. It is contemplated that thin cross-sectional mandrels, such as center mandrel 202, may be made of materials having relatively higher physical properties, such as epoxy resins.

The external components of third packer embodiment 200 which fit on the outside of center mandrel 202 are substantially identical to the outer components on second embodiment 100, and therefore the same reference numerals are shown in FIG. 4A. In a manner similar to second embodiment packer 100, center mandrel 202 and upper support 106 may be integrally formed so that there is no threaded connection 108.

The lower end of center mandrel 202 is attached to a valve housing 206 at threaded connection 208. On the upper end of valve housing 206 is an upwardly and inwardly tapered shoulder 210 against which shoulder 104 on lower slips 136 or 136' are slidably disposed. Thus, valve housing 206 may also be referred to as a lower slip support 206.

Referring now also to FIG. 4B, a sealing means, such as O-ring 212, provides sealing engagement between center mandrel 202 and valve housing 206.

Valve housing 206 defines a housing central opening including a bore 214 therein with a closed lower end 216. At the upper end of bore 214 is an annular recess 218. Valve housing 204 defines a plurality of substantially transverse ports 220 therethrough which intersect bore 214.

Slidably disposed in bore 214 in valve housing 206 is a sliding valve 222. At the upper end of sliding valve 222 are a plurality of collet fingers 224 which initially engage recess 218.

Sliding valve 222 defines a plurality of substantially transverse ports 226 therein which intersect a valve central opening 228 in the sliding valve. Valve central opening 228 is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of central opening 228 is a chamfered shoulder 230.

As shown in FIG. 4B, sliding valve 222 is in an uppermost closed position. It will be seen that the lower end of center mandrel 202 prevents further upward movement of sliding valve 222. When sliding valve 222 is moved downwardly to an open position, ports 226 are substantially aligned with ports 220 in valve housing 206. An alignment means, such as an alignment bolt 232, extends from valve housing 206 inwardly between a pair of adjacent collet fingers 224. A sealing means, such as O-ring 234, provides sealing engagement between alignment bolt 232 and valve housing 206. Alignment bolt 234 prevents rotation of sliding valve 222 within valve housing 204 and insures proper alignment of ports 226 and 220 when sliding valve 222 is in its downwardmost, open position.

The wall thickness of sliding valve 222 is sufficient to accommodate a pair of spaced seal grooves 234 are defined in the outer surface of sliding valve 222, and as seen in FIG. 4B, seal grooves 234 are disposed on opposite sides of ports 220 when sliding valve 222 is in the open position shown. A sealing means, such as seal 236, is disposed in each groove 234 to provide sealing engagement between sliding valve 222 and bore 214 in valve housing 206.

Referring again to FIG. 4A, a tension sleeve 238 is attached to the upper end of center mandrel 202 at threaded connection 240. A threaded portion 242 of tension sleeve 238 extends upwardly from center mandrel 202 and is adapted for engagement with a setting apparatus (not shown) of a kind known in the art.

An internal seal 244 is disposed in the upper end of center mandrel 202 below tension sleeve 238.

Fourth Packer Embodiment

Referring now to FIGS. 5A and 5B, a fourth squeeze packer embodiment is shown and generally designated by the numeral 300. As illustrated, fourth embodiment 300 has the same center mandrel 202, and all of the components positioned on the outside of center mandrel 202 are identical to those in the second and third packer embodiments. Therefore, the same reference numerals are used for these components. Tension sleeve 238 and internal seal 244 positioned on the inside of the upper end of center mandrel 202 are also substantially identical to the corresponding components in third embodiment packer 200 and therefore shown with the same reference numerals.

The difference between fourth packer embodiment 300 and third packer embodiment 200 is that in the fourth embodiment shown in FIGS. 5A and 5B, the lower end of center mandrel 202 is attached to a different valve housing 302 at threaded connection 304. Shoulder 140 on each lower slip 136 or 136' slidingly engages an upwardly and inwardly tapered shoulder 306 on the top of valve housing 302. Thus, valve housing 302 may also be referred to as lower slip support 302.

Referring now to FIG. 5B, a sealing means, such as O-ring 308, provides sealing engagement between the lower end of center mandrel 202 and valve housing 302.

Valve housing 302 defines a housing central opening including a bore 310 therein with a closed lower end 312. A bumper seal 314 is disposed adjacent to end 312.

Valve housing 302 defines a plurality of substantially transverse ports 316 therethrough which intersect bore 310. A sliding valve 318 is disposed in bore 310, and is shown in an uppermost, closed position in FIG. 5B. It will be seen that the lower end of center mandrel 202 prevents upward movement of sliding valve 318. Sliding valve 318 defines a valve central opening 320 therethrough which is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of valve central opening 320 in sliding valve 318 is an upwardly facing chamfered shoulder 322.

On the outer surface of sliding valve 318, a pair of spaced seal grooves 324 are defined. In the closed position shown in FIG. 5B, seal grooves 324 are on opposite sides of ports 316 in valve housing 302. A sealing means, such as seal 326, is disposed in each seal groove 324 and provides sealing engagement between sliding valve 318 and bore 310 in valve housing 302.

When sliding valve 318 is opened, as will be further described herein, the sliding valve 318 is moved downwardly such that upper end 328 thereof is below ports 316 in valve housing 302. Downward movement of sliding valve 318 is checked when lower end 330 thereof contacts bumper seal 314. Bumper seal 314 is made of a resilient material which cushions the impact of sliding valve 31 thereon.

Fifth Packer Embodiment

Referring now to FIGS. 6A and 6B, a fifth squeeze packer embodiment is shown and generally designated by the numeral 400. As illustrated, fifth packer embodiment 400 incorporates the same thick cross-sectional center mandrel 102 as does second packer embodiment 100 shown in FIGS. 3A and 3B. Also, the external components positioned on center mandrel 102 are the same as in the second, third and fourth packer embodiments, so the same reference numerals will be used.

Further, tension sleeve 174 and internal seal 180 in second embodiment 100 are also incorporated in fifth embodiment 400, and therefore these same reference numerals have also been used.

The difference between fifth packer embodiment 400 and second embodiment 100 is that the lower end of center mandrel 102 is attached to a lower slip support 402 at threaded connection 404. Shoulders 140 on lower slips 136 or 136' slidingly engage an upwardly and inwardly tapered shoulder 406 at the upper end of lower slip support 402.

Referring now to FIG. 6B, a sealing means, such as O-ring 408, provides sealing engagement between the lower end of center mandrel 102 and lower slip support 402.

Lower slip support 402 defines a first bore 410 therein and a larger second bore 412 spaced downwardly from the first bore. A tapered seat surface 414 extends between first bore 410 and second bore 412.

The lower end of lower support 402 is attached to a valve housing 416 at threaded connection 418. Valve housing 416 defines a first bore 420 and a smaller second bore 422 therein. An upwardly facing annular shoulder 424 extends between first bore 420 and second bore 422. Below second bore 422, valve housing 416 defines a third bore 426 therein with an internally threaded surface 428 forming a port at the lower end of the valve housing.

Disposed in first bore 420 in valve housing 416 is a valve body 430 with an upwardly facing annular shoulder 432 thereon. An elastomeric valve seal 434 and a valve spacer 436, which provides support for the valve seal, are positioned adjacent to shoulder 432 on valve body 430. A conical valve head 438 is positioned above valve seal 434 and is attached to valve body 430 at threaded connection 440. It will be seen by those skilled in the art that valve seal 434 is adapted for sealing engagement with seat surface 414 in lower slip support 402 when valve body 430 is moved upwardly.

The lower end of valve body 430 is connected to a valve holder 442 by one or more pins 444. Valve holder 442 is disposed in second bore 422 of valve housing 416. A sealing means, such as O-ring 446 provides sealing engagement between valve holder 442 and valve housing 416.

Above shoulder 424 in valve housing 416, valve body 430 has a radially outwardly extending flange 448 thereon. A biasing means, such as spring 450, is disposed between flange 448 and shoulder 424 for biasing valve body 430 upwardly with respect to valve housing 416.

Valve holder 442 defines a first bore 452 and a smaller second bore 454 therein with an upwardly facing chamfered shoulder 456 extending therebetween. A ball 458 is disposed in valve holder 442 and is adapted for engagement with shoulder 456.

First Bridge Plug Embodiment

Referring now to FIG. 7, a first bridge plug embodiment of the present invention is shown and generally designated by the numeral 500. First bridge plug embodiment 500 comprises the same center mandrel 102 and the external components positioned thereon as does the second packer embodiment 100. Therefore, the reference numerals for these components shown in FIG. 7 are the same as in FIG. 3A.

The lower end of center mandrel 102 in first bridge plug embodiment 500 is connected to a lower slip support 502 at threaded connection 504. An upwardly and inwardly tapered shoulder 506 on lower slip support 502 engages shoulders 140 on lower slips 136 or 136'. As with the other embodiments, slips 136 or 136' are adapted for sliding along shoulder 506.

Lower slip support 502 defines a bore 508 therein which is in communication with mandrel central opening 104 in center mandrel 102.

A bridging plug 510 is disposed in the upper portion of mandrel central opening 104 in center mandrel 102 and is sealingly engaged with internal seal 180. A radially outwardly extending flange 512 prevents bridging plug 510 from moving downwardly through center mandrel 102.

Above bridging plug 510 is tension sleeve 174, previously described for second packer embodiment 100.

Second Bridge Plug Embodiment

Referring now to FIG. 8, a second bridge plug embodiment of the present invention is shown and generally designated by the numeral 600. Second bridge plug embodiment 600 uses the same thin cross-sectional mandrel 202 as does third packer embodiment 200 shown in FIG. 4A. Also, the external components positioned on center mandrel 202 are the same as previously described, so the same reference numerals are used in FIG. 8.

In second bridge plug embodiment 600, the lower end of center mandrel 202 is attached to the same lower slip support 502 as first bridge plug embodiment 500 at threaded connection 602. It will be seen that bore 508 in lower slip support 502 is in communication with mandrel central opening 204 in center mandrel 202.

A bridging plug 604 is positioned in the upper end of mandrel central opening 204 in center mandrel 202. A shoulder 608 in central opening 204 prevents downward movement of bridging plug 604. A sealing means, such as a plurality of O-rings 606, provide sealing engagement between bridging plug 604 and center mandrel 202.

Tension sleeve 238, previously described, is positioned above bridging plug 604.

Setting And Operation Of The Apparatus

Downhole tool apparatus 10 is positioned in well bore 12 and set into engagement therewith in a manner similar to prior art devices made with metallic components. For example, a prior art apparatus and setting thereof is disclosed in the above-referenced U.S. Pat. No. 4,151,875 to Sullaway. This patent is incorporated herein by reference.

For first packer embodiment 20, the setting tool pulls upwardly on tension sleeve 62, and thereby on mandrel 22, while holding lock ring housing 24. The lock ring housing is thus moved relatively downwardly along mandrel 22 which forces upper slips 28 outwardly and shears screws 36, pushing upper slip wedge 32 downwardly against packer elements 40 and 42. Screws 50 are also sheared and lower slip wedge 46 is pushed downwardly toward lower slip support 58 to force lower slips 54 outwardly. Eventually, upper slips 28 and lower slips 54 are placed in gripping engagement with well bore 12 and packer elements 40 and 42 are in sealing engagement with the well bore. The action of upper slips 28 and 54 prevent packer 20 from being unset. As will be seen by those skilled in the art, pressure below packer 20 cannot force the packer out of well bore 12, but instead, causes it to be even more tightly engaged.

Eventually, in the setting operation, tension sleeve 62 is sheared, so the setting tool may be removed from the well bore.

The setting of second packer embodiment 100, third packer embodiment 200, fourth packer embodiment 300, fifth packer embodiment 400, first bridge plug embodiment 500 and second bridge plug embodiment 600 is similar to that for first packer embodiment 20. The setting tool is attached to either tension sleeve 174 or 238. During setting, the setting tool pushes downwardly on upper slip support 110, thereby shearing shear pin 112. Upper slips 116 or 116' are moved downwardly with respect to upper slip wedge 126. Tapers 120 in upper slips 116 or 116' slide along upper slip wedge 126, and shoulders 118 on upper slips 116 or 116' slide along shoulder 114 on upper slip support 110. Thus, upper slips 116 or 116' are forced radially outwardly with respect to center mandrel 102 or 202.

As this outward force is applied to slips 116 in the embodiment of FIGS. 9-11, retaining band 117 is broken, and slips 116 are freed to move radially outwardly such that edges 124 of inserts 122 grippingly well bore 12.

As the outward force is applied to alternate embodiment slips 116' (FIGS. 12-14), ring portion 121 will fracture, probably starting at the base of each gap 123. A typical fracture line 125 is shown in FIGS. 12 and 13. In other words, slips 116' separate and are freed to move radially outwardly such that edges 124 of inserts 122 grippingly engage well bore 12.

Also during the setting operation, upper slip wedge 126 is forced downwardly, shearing shear pin 128. This in turn causes packer elements 40 and 42 to be squeezed outwardly into sealing engagement with the well bore.

The lifting on center mandrel 102 or 202 causes the lower slip support (valve housing 144 in first packer embodiment 100, valve housing 206 in second packer embodiment 200, valve housing 302 in fourth packer embodiment 300, lower slip support 402 in fifth packer embodiment 400, and lower slip support 502 in first bridge plug embodiment 500 and second bridge plug embodiment 600) to be moved up and lower slips 136 or 136' to be moved upwardly with respect to lower slip wedge 130. Tapers 134 in lower slips 136 or 136' slide along lower slip wedge 130, and shoulders 140 on lower slips 136 or 136' slide along the corresponding shoulder 142, 210, 306, 406, or 506. Thus, lower slips 136 or 136' are forced radially outwardly with respect to center mandrel 102 or 202.

As this force is applied to slips 136 in the embodiment of FIGS. 9-11, retaining band 117 is broken, and slips 136 are freed to move radially outwardly such that edges 124 of inserts 138 grippingly engage well bore 12.

As the outward force is applied to alternate embodiment slips 136' (FIGS. 12-14), ring portion 137 will fracture, probably starting at the base of each gap 139. A typical fracture line 125 is shown in FIGS. 12 and 13. In other words, slips 136' separate and are freed to move radially outwardly such that edges 124 of inserts 138 grippingly engage well bore 12.

Also during the setting operation, lower slip wedge 130 is forced upwardly, shearing shear pin 132, to provide additional squeezing force on packer elements 40 and 42.

The engagement of inserts 122 in upper slips 116 or 116' and inserts 138 in lower slips 136 or 136' with well bore 12 prevent packers 100, 200, 300, 400 and bridge plugs 500, 600 from coming unset.

Once any of packers 20, 100, 200, 300, 400 are set, the valves therein may be actuated in a manner known in the art. Sliding valve 164 in second packer embodiment 126, and sliding valve 22 in third packer embodiment 200 are set in a similar, if not identical manner. Sliding valve 318 in fourth packer embodiment 300 is also set in a similar manner, but does not utilize collets, nor is alignment of sliding valve 318 with respect to ports 316 in valve housing 302 important. Sliding valve 318 is simply moved below ports 316 to open the valve. Bumper seal 314 cushions the downward movement of sliding valve 318, thereby minimizing the possibility of damage to sliding valve 318 or valve housing 302 during an opening operation.

In fifth packer embodiment 400, the valve assembly comprising valve body 432, valve seal 434, valve spacer 436, valve head 438 and valve holder 442 is operated in a manner substantially identical to that of the Halliburton EZ Drill® squeeze packer of the prior art.

Drilling Out The Packer Apparatus

Drilling out any embodiment of downhole tool 10 may be carried out by using a standard drill bit at the end of tubing string 16. Cable tool drilling may also be used. With a standard "tri-cone" drill bit, the drilling operation is similar to that of the prior art except that variations in rotary speed and bit weight are not critical because the non-metallic materials are considerably softer than prior art cast iron, thus making tool 10 much easier to drill out. This greatly simplifies the drilling operation and reduces the cost and time thereof.

In addition to standard tri-cone drill bits, and particularly if tool 10 is constructed utilizing engineering grade plastics for the mandrel as well as for slip wedges, slips, slip supports and housings, alternate types of drill bits may be used which would be impossible for tools constructed substantially of cast iron. For example, polycrystalline diamond compact (PDC) bits may be used. Drill bit 14 in FIG. 1 is illustrated as a PDC bit. Such drill bits have the advantage of having no moving parts which can jam up. Also, if the well bore itself was drilled with a PDC bit, it is not necessary to replace it with another or different type bit in order to drill out tool 10.

While specific squeeze packer and bridge plug configurations of packing apparatus 10 has been described herein, it will be understood by those skilled in the art that other tools may also be constructed utilizing components selected of non-metallic materials, such as engineering grade plastics.

Additionally, components of the various packer embodiments may be interchanged. For example, thick cross-sectional center mandrel 102 may be used with valve housing 206 in second packer embodiment 200 or valve housing 302 in fourth packer embodiment 300. Similarly, thin cross-sectional center mandrel 202 could be used with valve body 144 in second packer embodiment 100 or lower slip support 402 and valve housing 416 in fifth packer embodiment 400. The intent of the invention is to provide devices of flexible design in which a variety of configurations may be used.

It will be seen, therefore, that the downhole tool packer apparatus and methods of drilling thereof of the present invention are well adapted to carry out the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments of the apparatus and various drilling methods have been discussed for the purposes of this disclosure, numerous

changes in the arrangement and construction of parts and the steps of the methods may be made by those skilled in the art. In particular, the invention is not intended to be limited to squeeze packers or bridge plugs. All such changes are encompassed within the scope and spirit of the appended claims.

What is claimed is:

1. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means being at least partially made of a non-metallic material.

2. The apparatus of claim 1 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

3. The apparatus of claim 2 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means being at least partially made of a non-metallic material.

4. The apparatus of claim 1 wherein said slip means comprises a slip support made of a non-metallic material.

5. The apparatus of claim 1 wherein said slip means comprises a slip wedge made of non-metallic material.

6. The apparatus of claim i wherein said slip means comprises:

a plurality of non-metallic slips disposed in an initial position around said mandrel; and

retaining means for holding said slips in said initial position.

7. The apparatus of claim 6 wherein said retaining means is characterized by a retaining band extending at least partially around said slips.

8. The apparatus of claim 6 wherein said retaining means comprises a non-metallic ring portion integrally formed with said slips and being fracturable during a setting operation, whereby said slips are separated.

9. The apparatus of claim 8 wherein said slips define a plurality of gaps therebetween adjacent to an end of said slips.

10. The apparatus of claim 6 further comprising a plurality of hardened inserts molded into said slips

11. The apparatus of claim 10 wherein said inserts are steel.

12. The apparatus of claim 10 wherein said inserts are made of a non-metallic material.

13. The apparatus of claim 12 wherein said inserts are made of a ceramic material.

14. The apparatus of claim 1 wherein said non-metallic material is an engineering grade plastic.

15. The apparatus of claim 14 wherein said plastic is nylon.

16. The apparatus of claim 14 wherein said plastic is a phenolic material.

17. The apparatus of claim 16 wherein said phenolic material is one of Fiberite FM4056J, Fiberite FM4005 and Resinoid 1360.

18. The apparatus of claim 14 wherein said plastic is an epoxy resin.

19. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel;

a slip wedge disposed around said mandrel;

a plurality of separate non-metallic slips disposed around said mandrel adjacent to said wedge; and

retaining means for retaining said slips in an initial position out of engagement with the well bore.

20. The apparatus of claim 19 wherein said wedge is made of a non-metallic material.

21. The apparatus of claim 19 wherein said slips are made of engineering grade plastic.

22. The apparatus of claim 21 wherein said plastic is nylon.

23. The apparatus of claim 21 wherein said plastic is a phenolic material.

24. The apparatus of claim 21 wherein said phenolic material is Fiberite FM4056J.

25. The apparatus of claim 21 wherein said plastic is an epoxy resin.

26. The apparatus of claim 19 further comprising a plurality of inserts molded into said slips for grippingly engaging the well bore when in a set position.

27. The apparatus of claim 26 wherein said inserts are hardened steel.

28. The apparatus of claim 26 wherein said inserts are made of a non-metallic material.

29. The apparatus of claim 28 wherein said inserts are made of a ceramic material.

30. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel;

a slip wedge disposed around said mandrel;

a plurality of non-metallic slips disposed around said mandrel adjacent to said wedge; and

a non-metallic ring integrally formed at an end of each of said slips and adapted for holding said slips in an initial position out of engagement with the well bore.

31. The apparatus of claim 30 wherein said wedge is made of a non-metallic material.

32. The apparatus of claim 31 wherein said slips define a plurality of longitudinally extending gaps therebetween adjacent to an opposite end of said slips from said ring.

33. The apparatus of claim 30 wherein said ring is made of a fracturable engineering grade plastic.

34. The apparatus of claim 33 wherein said plastic is nylon.

35. The apparatus of claim 33 wherein said plastic is a phenolic material.

36. The apparatus of claim 33 wherein said phenolic material is Fiberite FM4056J.

37. The apparatus of claim 33 wherein said plastic is an epoxy resin.

38. The apparatus of claim 30 further comprising a plurality of inserts molded into said slips for grippingly engaging the well bore when in a set position.

39. The apparatus of claim 38 wherein said inserts are hardened steel.

40. The apparatus of claim 38 wherein said inserts are made of a non-metallic material.

41. The apparatus of claim 38 wherein said inserts are made of a ceramic material.

* * * * *

CERTIFICATE OF COMPLIANCE

I certify that the foregoing BRIEF FOR APPELLANT HALLIBURTON ENERGY SERVICES, INC. contains 13,966 words as measured by the word processing software used to prepare this brief.

Dated: December 15, 2003

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that two copies of the foregoing BRIEF FOR APPELLANT HALLIBURTON ENERGY SERVICES, INC. were served this 15th day of December, 2003, upon counsel of record listed below by overnight Federal Express:

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ORIGINAL

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

HALLIBURTON ENERGY SERVICES, INC.	§	
	§	
Plaintiff,	§	
	§	
v.	§	Civil Action No. 3:02-CV-1347-N
	§	
WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY	§	
	§	
Defendants,	§	

MEMORANDUM OPINION AND ORDER

Plaintiff Halliburton Energy Services, Inc. ("Halliburton") complains against Defendant Weatherford International, Inc. ("Weatherford") and Defendant BJ Services Company ("BJ") for patent infringement under 35 U.S.C. §§ 1, *et seq*. Halliburton seeks judgment against the Defendants and injunctive relief against further infringement of the claims of United States Patent Number 5,271,468 (the " '468 patent"), issued December 21, 1993 and United States Patent Number 5,224,540 (the " '540 patent"), issued July 6, 1993, each entitled "Downhole Tool Apparatus with Non-Metallic Components and Methods of Drilling Thereof."

Before the Court is Halliburton's motion for a preliminary injunction. Oral arguments were held on September 19, 2002. After considering the Parties' briefs and arguments, and for the reasons stated below, this motion is DENIED.

A 1

I. Background

Halliburton, Weatherford, and BJ all provide services and equipment to customers in the oil industry. Halliburton's patents at issue in this action relate to oil well tools called bridge plugs, see Figure 1 from the '468 patent at right. Bridge plugs are used to seal off or "plug" portions of an oil well during certain oil production procedures. Often times after the procedures are complete, bridge plugs are removed from the oil wells. The claims at issue for the purpose of deciding this motion pertain to the bridge plug apparatus itself and a method of setting the bridge plug in a well bore[1] and then removing the plug by drilling it out. Figure 1 illustrates a bridge plug set in place in a well casing about to be drilled out and removed from the well.

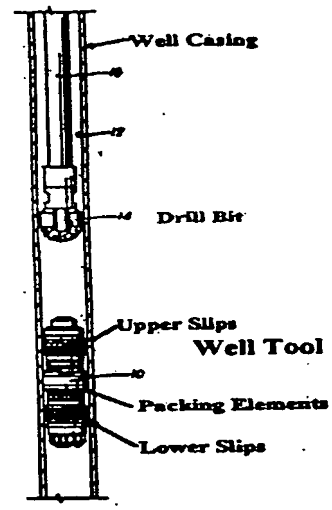

FIG. 1

5,271,468

Traditionally, bride plugs were constructed of metals such as steel or cast-iron. The relevant claims of Halliburton's '468 and '540 patents pertain to bridge plugs made of non-metallic component parts. The relevant component parts of a bridge plug include (1) a center mandrel – the main structural body on which the tool is built, (2) a packing element – an

[1] A well bore is a hole made by a drilling rig. Oil and gas wells are drilled into the earth using large drilling rigs capable of lifting and rotating long, heavy strings of drill pipe with a drill bit at the end. These wells can be very deep, penetrating thousands of feet into the earth. After the well is drilled, a string of relatively large-diameter tubing called casing is lowered into the well bore by the drilling rig and then cemented into place. For the purposes of this opinion, the well bore and the well casing are treated as the same structures.

often doughnut-shaped, rubber element positioned around the center mandrel to seal off the lower portion of the well bore, and (3) slips – anchoring assemblies to hold the tool in place. Figure 8 from the '468 patent, depicted on the right, demonstrates one embodiment of Halliburton's bridging plug. The anchoring components in figure 8 consist of upper and lower slips, slip supports, and wedges. When the well tool is set, the packer elements are compressed and expand to form a seal with the well casing (as shown). This expansion pushes the upper wedge upward and the lower wedge downward and the forces the slips outward to engage the well casing. In this embodiment of the Halliburton's invention, the slip supports help hold the slips, and therefore the bridge plug, in place in the well bore. Halliburton claims that its tool's non-metallic composition allows for a less expensive and more reliable removal of the plug from an oil well bore.

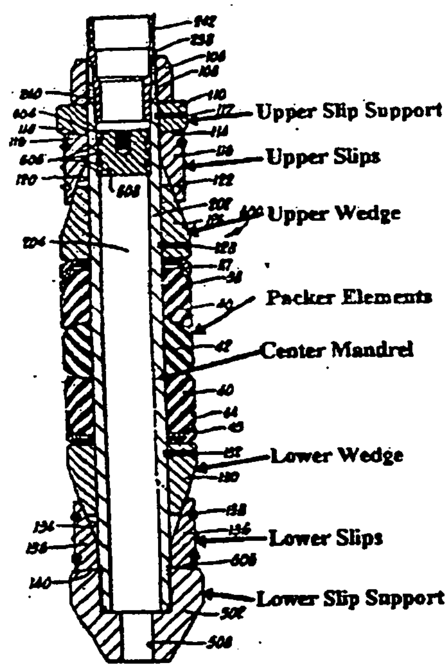

FIG. 8

5,271,468

Halliburton's non-metallic bridge plugs, marketed as part of their FAS DRILL® tool line, are removed by drilling the plugs out of the well bore. The plugs are drilled into small bits and chips that can be circulated through and flushed out of the well bore. Halliburton asserts that prior to its non-metallic tools, most drillable bridge plugs were constructed of cast-iron. These cast-iron plugs were more costly and problematic to drill out of well bores

than non-metallic plugs. Halliburton claims that its FAS DRILL® plugs can be removed from well bores with less expensive equipment, in less time, and with fewer problems than their metallic counterparts.

Halliburton contends in its motion that Weatherford and BJ are infringing upon claims 1 and 30 of its '468 patent and claim 3, which is dependent upon claim 2, which is dependent upon claim 1, of its '504 patent. These claims read as follows:

Claim 1 of the '468 Patent

> 1. A well bore process comprising the steps of:
> constructing a downhole tool such that a component thereof is made of a non-metallic material, said tool comprising:
> a center mandrel; and
> a plurality of slips disposed around said mandrel for grippingly engaging a well bore when in a set position;
> wherein at least one of said mandrel and said plurality of slips is said component;
> positioning said downhole tool into locking, sealing engagement with said well bore; and
> drilling said tool out of said well bore.

Claim 30 of the '468 Patent

> 30. A downhole apparatus for use in a well bore, said apparatus comprising:
> a center mandrel made of non-metallic material; and
> slip means disposed on said mandrel for grippingly engaging said well bore when in set position.

Claims 1-3 of the '540 Patent

> 1. A downhole apparatus for use in a well bore, said apparatus comprising:
> a center mandrel; and
> slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means being at least partially made of a non-metallic material.

> 2. The apparatus of claim 1 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.
>
> 3. The apparatus of claim 2 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means being at least partially made of a non-metallic material.

Halliburton argues that Weatherford's FracGuard Composite plugs and BJ's Python Composite plug incorporate aspects of its FAS DRILL® tools and infringe upon the cited patent claims. The Defendants' plugs, Halliburton asserts, have non-metallic center mandrels and slip assemblies made at least partially of non-metallic materials. Additionally, Halliburton claims that the Defendants' marketing materials boast quick and easy drill outs of their composite (non-metallic) plugs.

II. Discussion

To obtain a preliminary injunction, Halliburton must show "(1) a reasonable likelihood of success on the merits; (2) irreparable harm if an injunction is not granted; (3) a balance of hardships tipping in its favor; and (4) the injunction's favorable impact on the public interest." *Amazon.com, Inc. v. Barnesandnoble.com, Inc.*, 239 F.3d 1343, 1350 (Fed. Cir. 2001). With regard to the first element, Halliburton must show, in light of the burdens that will inhere at trial, that (1) its patent was infringed, and (2) any challenges to the validity and enforceability of its patent "lack substantial merit." *Purdue Pharma L.P. v. Boehringer Ingelheim GmbH*, 237 F.3d 1359, 1366 (Fed. Cir. 2001).

Weatherford and BJ challenge the validity of Halliburton's patents. Specifically, the Defendants claim that Halliburton's relevant patent claims were anticipated or rendered obvious by prior art. An assessment of the likelihood of validity of a patent claim over the prior art also involves a two-step process. First, the court determines the scope and meaning of the patent claims asserted to determine the subject matter for which patent protection is sought. *See Smiths Indus. Med. Sys., Inc. v. Vital Signs, Inc.*, 183 F.3d 1347, 1353 (Fed. Cir. 1999). Secondly, the properly construed claims are compared with the prior art. *Id.* at 1354. A determination that a claim is invalid as being anticipated or lacking novelty under 35 U.S.C. § 102 requires a finding that "each and every limitation is found either expressly or inherently in a single prior art reference." *Celeritas Techs. Inc. v. Rockwell Int'l Corp.*, 150 F.3d 1354, 1361 (Fed. Cir. 1998). Whether a claim would have been obvious within the meaning of 35 U.S.C. § 103 is a question of law based on underlying findings of fact including: "(1) the scope and content of the prior art, (2) the level of ordinary skill in the art, (3) the differences between the claimed invention and the prior art, and (4) secondary considerations of nonobviousness." *Smiths*, 183 F.3d at 1354 (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)).

Because an issued patent is presumed to be valid, 35 U.S.C. § 282, the Defendants must establish invalidity by clear and convincing evidence. *WMS Gaming Inc. v. Int'l Game Techs.*, 184 F.3d 1339, 1355 (Fed. Cir. 1999). In the context of a preliminary injunction, however, while "the burden of proving invalidity is with the party attacking validity," the party seeking the injunction "retains the burden of showing a reasonable likelihood that the

attack on its patent's validity would fail." *H.H. Robertson Co. v. United Steel Deck, Inc.*, 820 F.2d 384, 387 (Fed. Cir. 1987). When the presumptions and burdens applicable at trial are taken into account, the injunction should not issue if the party opposing the injunction raises "a substantial question concerning infringement or validity, meaning that it asserts a defense that [the party seeking the injunction] cannot prove lacks substantial merit." *Tate Access Floors v. Interface Architectural Resources, Inc.*, 279 F.3d 1357, 1365 (Fed. Cir. 2002) (internal quotation marks omitted); *New Eng. Braiding Co. v. A.W. Chesterton Co.*, 970 F.2d 878, 883 (Fed. Cir. 1992) ("While it is not the patentee's burden to prove validity, the patentee must show that the alleged infringer's defense lacks substantial merit.").

A. Anticipation by the '266 Patent

Both Defendants argue that Halliburton's patents are invalid because of anticipation. A patent is anticipated and therefore invalid when the invention was described in a printed publication either before the date of invention by the applicant or more than one year before the date of the application for the patent in the United States. 35 U.S.C. §§ 102(a), 102(b) (2003). For a claim to be invalid on the basis of anticipation under section 102(b), "[t]he invention must have been known to the art in the detail of the claim; that is, all of the elements and limitations of the claim must be shown in a single prior art reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001).

Weatherford argues in its surreply that United States Patent Number 1,684,266 (the " '266 patent"), entitled "Bridging Plug," issued on September 11, 1928 anticipates the

relevant claims of Halliburton's '468 and '540 patents. The '266 patent is for an improved bridge plug made of wood, a non-metallic material.[2] This patent raises a substantial question regarding the validity of Halliburton's relevant patent claims.

1. Claim 1 of the '468 Patent

Claim 1 of the '468 patent describes a process for (i) locking and (ii) sealing an oil well tool, i.e. bridge plug, in a well bore and then (iii) drilling the tool out of the hole. The '468 tool apparatus itself contains (iv) a center mandrel and (v) a plurality of slips (for positioning the tool in place) wherein (vi) either the mandrel or the slips are made of a non-metallic material. In comparison, the '266 patent discloses a bridging plug that has (iv) a center mandrel constructed of (vi) wood that can be easily (iii) drilled out of a well bore. App. at W00213, lines 16-21, 90-98. The '266 plug utilizes a (v) plurality of slips that (i) engage the well bore to prevent movement of the tool when the plug is set. App. at W000214, lines 3-12. The '266 bridging plug also has rubber rings distributed around the mandrel for (ii) sealingly engaging the well bore when the plug is locked in position. *Id.* at lines 68-73. The '266 patent, therefore, discloses the elements and limitations of Claim 1 of the '468 patent.

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[2] The Patent and Trademark Office ("PTO") did not review the '266 patent prior to its issuance of Halliburton's patents-in-suit. "Deference is due the PTO's decision to issue a patent with respect to evidence bearing on validity which it considered but no such deference is due with respect to evidence it did not consider." *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1359 (Fed. Cir.), *cert. denied*, 469 U.S. 821 (1984).

2. Claim 30 of the '468 Patent

The '266 patent likewise appears to anticipate Claim 30 of the '468 patent. Claim 30 describes the bridge plug apparatus as comprising (i) a non-metallic center mandrel and (ii) a slip means disposed on the mandrel for grippingly engaging the well bore when the tool is in a set position. As discussed above, the '266 patent discloses a bridging plug apparatus containing (i) a non-metallic (wood) center mandrel and a plurality of slips for locking, or grippingly engaging, the well bore when the tool is set. The apparatus of claim 30 however differs from claim 1 in that 30 requires the apparatus to contain a "slip means." Halliburton argues that "slip means," as defined in the specification of the patent-in suit, includes (a) slips, (b) a cone for wedging the slips, and (c) a support structure for the slips on the opposite side of the slips from the wedge. App. at 000010, col. 3, l. 26-28; App. at 000029, col. 29-34. The Defendants do not offer an alternate construction of slip means. In response to Halliburton's construction of "slip means," Weatherford argues that the '266 plug utilizes (a) slips and (b) a tapered, conical wooden component that wedges the slips into engagement with the well bore. Weatherford, however, does not directly address in its argument whether the '266 patent discloses the element of a slip support structure on the opposite side of the slips from the wedge.

A *Markman* hearing will ultimately determine the proper construction of the term "slip means," however, for the purposes of this motion, the "slip means" language is broad enough to apply to the slip structure disclosed in the '266 patent. When claims are drafted in "means plus function" form, the presumption is that 35 U.S.C. § 112 ¶ 6 applies. A "means plus

function" claim limitation is construed to cover the structure disclosed in the specification of the patent to perform the claimed function plus equivalents of that structure. *Caterpillar Inc. v. Deere & Co.*, 224 F.3d 1374, 1379 (Fed. Cir. 2000).

The means plus function limitation does not override, however, the section 112 requirement that the claims particularly point out and distinctly claim the subject matter of the invention. *In re Donaldson Co.*, 16 F.3d 1189, 1195 (Fed. Cir. 1994). A claim can not be limited by reading the specification into the claim:

> it is the language itself of the claims which must particularly point out and distinctly claim the subject matter which the applicant regards as his invention, without limitations imported from the specification, whether such language is couched in terms of means plus function or consists of a detailed recitation of the inventive matter. Limitations in the specification not included in the claim may not be relied upon to impart patentability to an otherwise unpatentable claim.

In re Lundberg, 244 F.2d 543, 548 (C.C.P.A. 1957).

Claim 30 of Halliburton's '468 patent requires a slip means disposed on the tool's mandrel for grippingly engaging the well bore when the tool is in a set position. The claims of the '266 patent disclose slips engageable upon the casing, designed to prevent upward and downward movement of the plug within the casing. Functionally, both slip structures engage the well bore or well casing to prevent movement of the plug when the tool is set. If the precise structure of the "slip means" was critical to establishing the novelty of Halliburton's invention, then it was incumbent upon Halliburton to particularly point out and distinctly claim that structure. Because Halliburton's patent claims do not include a support structure

for the slips on the opposite side of the slips from the wedge, the Court declines to read this limitation into claim 30 of the '468 patent in order to avoid the anticipation of the '468 patent by the '266 patent. A slip support on the opposite side of the slips from the wedge, therefore, is not a necessary element of "slip means." The '266 patent, thus, discloses the elements and limitations of claim 1 of the '468 patent.

3. Claims 1-3 of the '540 Patent

Claim 3 of the '540 patent, like claim 30 of the '468 patent, is an apparatus claim describing the bride plug. The elements of claim 3, which is dependent upon claim 2, which is dependent upon claim 1, include (i) a center mandrel, (ii) a packing means disposed on the mandrel for sealingly engaging the well bore when the tool is set, (iii) a partially non-metallic slip means, wherein the slip means consists of (a) an upper slip means disposed above the packing means, and (b) a lower slip means, being at least partially non-metallic, disposed below the packing means. The '266 patent discloses these elements and limitations and therefore anticipates claim 3 of the '540 patent.

As discussed previously, the bridging plug described in the '266 patent has a (i) center mandrel. The '266 tool also has (ii) a packing means – rubber rings and possibly wooden segments[3] disposed on the mandrel that sealingly engage the well bore when the tool is set. App. at W000214, lines 68-73 ("The rubber rings 22 also engage the casing and are compressed, thus forming a packer or seal to prevent the leakage of fluid between the

[3]The wooden segments of the '266 tool form a cylinder around the mandrel, and when the tool is set, the segments push on the slip cones to lock the slips in the well bore.

exterior surface of the segments 10 and the casing."). As discussed in construing the elements of claim 30, the '266 tool contains (iii) a slip means partially made of wood. Additionally, the slip means consists of (a) upper slips located above the rubber rings and (b) lower slips located below the rings. App. W000214, l. 3-12 ("These [upper] slips have upwardly directed teeth 18, which, when they engage the casing C, will prevent upward movement of the plug within the casing. Each of the segments 10 has a stationary slip 19 secured to its lower end, these slips being provided with downwardly directed teeth 20, which, when they engage the casing, will prevent downward movement of the plug.") The lower slip means also utilize the wooden conical element for wedging the slips, therefore the lower slip means are partially non-metallic. The '266 patent, therefore, discloses the elements and limitations of Claim 3 of the '540 patent, and claims 1 and 30 of the '468 patent.

4. Halliburton Has Not Shown that Weatherford's Anticipation Defense Lacks Substantial Merit

Weatherford has succeeded with its burden of raising a substantial question regarding the validity of the relevant claims of Halliburton's patents-in-suit. Halliburton, however, has failed to show that Weatherford's defense lacks substantial merit. In its response to Weatherford's surreply, Halliburton argues that the '266 tool (1) cannot seal the well bore, (2) does not have a plurality of slips disposed on the mandrel, and (3) has no seal member on the mandrel. The Plaintiff's arguments are unavailing.

First, the relevant claims of Halliburton's patents do not require that the bridging plug perfectly seal the well bore. Claim 1 of the '468 patent, rather, requires that the bridge plug is positioned into a locking, sealing engagement with the well bore, and claim 2 of the '540 patent requires a packing means disposed on said mandrel for sealingly engaging the well bore. The '266 tool does sealingly engage the well bore – the '266 plug has rubber rings that engage the well bore when compressed "thus forming a packer or seal to prevent the leakage of fluid between the exterior surface of the segments 10 and the casing." App. at W000214, lines 70-73.

Halliburton's attorney further argued at the preliminary injunction hearing that the '266 plug does not sealingly engage the well bore because the spaces between the tool's wooden segments[4] form leak paths. The proper inquiry for a claim to be invalid on the basis of anticipation requires that "all of the elements and limitations of the claim be shown in a single prior art reference, arranged as in the claim." *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 (Fed. Cir. 2001). The language of the '266 patent discloses a tool that sealingly engages the well casing or well bore, therefore Halliburton's argument that the '266 plug does not actually seal the well bore fails to rebut Weatherford's invalidity defense.

Next, Halliburton argues that the '266 bridging plug does not have a plurality of slips disposed on the mandrel, rather the slips are on the tool's segments. In this argument, Halliburton mischaracterizes its claims. Claim 1 of the '468 patent requires "a plurality of

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[4]See footnote 3 for a description of segments.

slips disposed *around* said mandrel." Dispose means "to place or set in a particular order" or "to arrange." *See* THE AMERICAN HERITAGE® DICTIONARY OF THE ENGLISH LANGUAGE (4th ed. 2000). The slips of the '266 tool are placed or arranged around the mandrel. Claim 30 of the '468 patent and claim 1 of the '540 patent require that the *slip means*, rather than the slips themselves, is disposed on the mandrel. This argument fails for the purpose of determining this motion because the term "disposed on" does not require that the slip means be physically attached to the mandrel. The slip means of the '266 plug is arranged on the mandrel. Halliburton's argument regarding the disposition of the '266 slips thus fails.

Lastly, Halliburton asserts that the '266 tool does not have a seal member on the mandrel. Halliburton's patent claims, however, require only that a "packing means" be disposed on the mandrel. The rubber rings of the '266 patent are arranged on the mandrel, therefore Halliburton's defense fails. Halliburton, thus, has not shown that Weatherford's defense of anticipation fails. Halliburton's motion for preliminary injunction is denied, because Weatherford raised a substantial question regarding the validity of the relevant claims of Halliburton's '468 and '540 patents.

B. Obviousness of the '468 and '540 Patents

The Defendants also argue that prior art renders the relevant claims of Halliburton's patents-in-suit obvious. A patent claim will be invalid if it is obvious to one of ordinary skill in the pertinent art:

> [a] patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at

> the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. §103(a) (2003). The determination of obviousness can be made by comparing the claimed device to a single prior art reference. However, the obviousness determination is often made by comparing the claimed device to a combination of references. *Karsten Mfg. Corp.*, 242 F.3d at 1385. "In holding an invention obvious in view of a combination of references, there must be some suggestion, motivation, or teaching in the prior art that would have led a person of ordinary skill in the art to select the references and combine them in the way that would produce the claimed invention." *Id.* The Defendants argue in their responses and surreplies that a number of publications either alone, or in combination, render both the '468 and '540 patents obvious.

1. Baker Tools

Both Defendants argue in their briefs that publications describing Baker Oil Tools' ("Baker") Prime Fiberglass Packer[5] and AD-Type Fiberglass Packer (collectively the "Baker tools") render obvious claims 1 and 30 of the '468 patent and claims 1 and 2 of the '540 patent. Baker's 1968 Special Products Manual discloses the Baker Fiberglass Packer and a 1968 World Oil Advertisement (collectively "Baker references") discloses both Baker tools. The Baker references predate the filing of the '468 and '540 patents by more than twenty years, and the patent examiner did not consider these materials during the prosecution of

[5]For the purposes of this opinion, packers and bridge plugs are considered to be similar downhole oil well tools.

Halliburton's patents-in-suit. These references appear to raise a substantial question about the validity of some of the relevant claims of Halliburton's patents.

The components of the Baker tools include a packing element and a plurality of slips disposed around a center mandrel. All components of the Prime Fiberglass Packer are constructed of non-metallic substances, and the mandrel of the AD-Type Fiberglass Packer is made of a non-metallic substance. Halliburton argues that the Baker tools could not be positioned into a locking, sealing engagement with the well bore. However, the function of the slips is to "bite into the casing" or lockingly engage the well bore, and the packing element is designed to sealingly engage the well bore. The incorporation of these design elements coupled with the description in the Special Products Manual for "running" or setting the tool suggest that the Baker tools could be positioned into a locking, sealing engagement with the well bore.

Halliburton further argues that the Baker tools do not have the necessary element of a slip support on the opposite side of the cone as part of the slip means. As discussed above, a slip support opposite the cone is not a necessary element of "slip means" for the purposes of deciding this motion. Thus, the Baker tools' slip mechanism is consistent with the defined term "slip means." The Baker references, therefore, anticipate or render obvious claim 30 of the '468 patent and claims 1 and 2 of the '540 patent.

The Baker references do not disclose the drill out element in claim 1 of '468 patent. The Defendants argue that persons skilled in the art knew to drill out bridge plugs from well bores if the tools became stuck. The Baker references coupled with this general knowledge

do not render obvious Halliburton's method claim. Claim 1 of the '468 patent describes a process for routinely setting a well tool and then drilling it out. The abnormal drill out of a malfunctioning bridge plug is not a customary part of the process for setting the Baker tools nor is there any suggestion in the references themselves that the Baker tools could or should be drilled out. The Baker references and the knowledge of abnormal plug drill outs do not render obvious claim 1 of the '468 patent.

The Defendants also argue that the Baker references, combined with other prior art, such as United States Patent Number 4,708,202 (the " '202" patent), suggest routine drill out of bridge plugs. The '202 patent and the '266 patent discussed above disclose that drilling out downhole tools, such as packers and bridge plugs, constructed of non-metallic components is desirable. These patents specifically state that non-metallic components improve the drillabillity of well tools. The coupling of the Baker references with either the '202 patent or the '266 patent renders claim 1 of the '468 patent obvious.

2. Other Prior Art References

The Defendants also argue that other prior art references, taken together with the Baker references, render the relevant claims of the patents-in-suit obvious. The Defendants state that the '202 patent, entitled "Drillable Well-Fluid Flow Control Tool," issued on November 24, 1987 discloses every element and limitation of Halliburton's claim 1 and 30 of the '468 patent and claims 1 and 2 of the '540 patent except the non-metallic mandrel or slips. The Baker references, Defendants argue, coupled with the '202 patent render these claims obvious. Additionally, the '202 patent itself discusses "forming a number of the

components of the tool from [non-metallic substances]" to improve the tools' drillability. App. Pl. at 000130, col. 7, l. 23-27. This language suggests forming tool components, such as the mandrel or slips, from non-metallic substances, and the Baker Special Products Manual discloses packers constructed entirely of non-metallic substances. The '202 patent and the Baker references, therefore, raise a substantial question as to the validity of claims 1 of the '468 patent and claims 1 and 2 of the '540 patent.

Defendants also argue United States Patent Number 3,306,366 (the " '366 patent"), entitled "Well Packer Apparatus," issued on February 28, 1967 discloses the common geometry of well tools with slips above and below the packing means that act in opposite directions. This slip geometry is consistent with the '266 patent discussed above. The upper slip assembly prevents the plug from moving upward in the well and the lower slip assembly prevents downward movement. The combination of the Baker references with the slip geometry disclosed in both the '875 and '266 patent appears to raise a substantial question as to the validity of claim 3 of the '540 patent.

Whether a claim would have been obvious within the meaning of 35 U.S.C. § 103 is a question of law based on underlying findings of fact including: the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art. In light of these factual determinations discussed above, the relevant claims of Halliburton's patents-in-suit are obvious. Secondary considerations such as commercial success, long felt but unsolved needs, failure of others, copying and unexpected results may also be utilized "to give light to the circumstances surrounding the

origin of the subject matter sought to be patented." *Graham v. John Deere Co.* U.S. 1, 17-18 (1966). These secondary factors favor a finding of nonobviousness of Halliburton's patents-in-suit: Halliburton's FAS DRILL® tools have enjoyed commercial success; the marketplace needed an easily drillable bridge plug; others, such as Mr. Harris, attempted but failed in designing and testing such a drillable tool; and Halliburton has presented evidence of the alleged copying of its FAS DRILL® tools by the Defendants. However, the factual determinations pertaining to the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art overcome the secondary considerations. The Defendants, therefore, have raised a substantial question regarding the obviousness of the relevant claims of Halliburton's patents-in-suit.

III. Conclusion

The Defendants have shown a substantial question regarding the validity of relevant claims of the patents-in-suit. The '266 patent anticipates claims 1 and 30 of the '468 patent and claims 1-3 of the '540 patent. The Baker references alone anticipate or render obvious claim 30 of the '468 patent and claims 1 and 2 of the '540 patent. The Baker references taken together with the '202 patent or '266 patent render obvious claim 1 of the '468 patent and claims 1 and 2 of the '540 patent. Lastly, the Baker references and the '366 or '266 patent render obvious claim 3 of the '540 patent.

Halliburton has not show that the Defendants' attacks on its patents lack substantial merit. Thus, Halliburton has not demonstrated a likelihood of success on the merits of its claims at trial. Therefore, Halliburton's motion for a preliminary injunction is denied.[6]

SIGNED this 4 day of March, 2003.

David C. Godbey
United States District Judge

[6]In light of this order, (1) Halliburton's motion for expedited discovery filed on June 27, 2002, (2) Halliburton's motion for temporary restraining order filed on June 27, 2002, (3) Weatherford's and BJ's motion for enlargement of time filed on July 1, 2002, (4) Halliburton's motion to strike filed on August 27, 2002, (5) Weatherford's motion to strike the declarations in support of Halliburton's requests for preliminary relief filed on September 11, 2002, and (6) Weatherford's motion to strike Halliburton's consolidated response to Defendants' sur-replies or, alternatively, motion for leave to file a reply brief filed on September 11, 2002 are denied as moot.

ORIGINAL

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

U.S. DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
FILED
AUG 26
CLERK, U.S. DISTRICT COURT
By ____________
Deputy

HALLIBURTON ENERGY SERVICES, INC.,	§	
	§	
Plaintiff,	§	
	§	
v.	§	Civil Action No. 3-02-CV-1347-N
	§	
WEATHERFORD INTERNATIONAL, INC. and BJ SERVICES COMPANY,	§	
	§	
Defendants.	§	

ORDER

Before the Court is Plaintiff Halliburton Energy Services, Inc.'s ("Halliburton") motion for reconsideration of the Court's memorandum opinion and order, entered March 5, 2003, ("Order") denying Halliburton's motion for preliminary injunction. Though Halliburton identifies neither the procedural basis nor the standard for its motion, the Court will consider it a motion to alter or amend judgment pursuant to Federal Rule of Civil Procedure 59(e). *See Lavespere v. Niagra Machine & Tool Works, Inc.*, 910 F.2d 167, 173 (5th Cir. 1990), *cert. denied*, 510 U.S. 859 (1993). Halliburton argues in its motion that it is entitled to reconsideration because of an intervening change in the law controlling the Court's denial of its motion for preliminary injunction, citing *Amgen, Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313 (Fed. Cir. 2003).[1] The Court denies Halliburton's motion to

[1]Halliburton offers additional grounds for reconsideration in its reply, however, the grounds are not proper under Rule 59(e), *see In re Benjamin Moore & Co.*, 318 F.3d 626, 629 (5th Cir. 2002), and the Court will not consider an argument raised for the first time in a reply

A 21

alter or amend judgment because the Federal Circuit's decision in *Amgen* did not change the controlling law.

The Court denied Halliburton's motion for preliminary injunction, in part, because Defendant Weatherford International, Inc. ("Weatherford") raised a substantial question regarding the validity of the patents-in-suit; Weatherford argued that United States Patent Number 1,684,266, entitled Bridging Plug, issued on September 11, 1928, (the " '266 patent") anticipated the patents-in-suit. Because Halliburton did not show that Weatherford's attack on its patents lacked substantial merit, Halliburton could not demonstrate a likelihood of success on the merits of its claims, and the Court denied its motion for preliminary injunction.

Halliburton now argues and offers evidence for the first time that the '266 Patent does not anticipate the patents-in-suit because it is not enabling. Specifically, Halliburton asserts that the '266 Patent is not enabling because the tool disclosed does not seal the well bore. Halliburton's excuse for its belated argument is that the law pertaining to the party with the burden of showing that the '266 Patent is or is not enabling changed; Halliburton states that it relied upon the treatise *Chisum on Patents* for the proposition that a patent validity challenger must initially bear the burden of producing some evidence that a reference, such as the '266 Patent, is enabling. *See* CHISUM ON PATENTS § 3.04 [1][b][v], at 3-102 to 3-103 (2002) ("Chisum"). The Federal Circuit in *Amgen*, Halliburton argues, changed Professor Chisum's understanding of the law and held that a patentee bears the burden of offering

brief. *See Lacher v. West*, 147 F. Supp. 2d 538, 540 & n.2 (N.D. Tex. 2001).

evidence of whether prior art, cited as evidence of invalidity, fails to enable the claimed invention. *See Amgen*, 314 F.3d at 1355. Halliburton's argument is unpersuasive.

First, though Professor Chisum is an expert in the area of patent law and his treatise an esteemed secondary source, it does not constitute *controlling* precedent; though courts may choose to adopt his rationale, they are by no means bound by it. Second, Halliburton's *Chisum* reference does not state definitively that the law pertaining to the burden of proof on enablement is settled; quite to the contrary, *Chisum* cites several district court opinions that presume a prior art reference to be enabling, thereby requiring the patentee to initially produce some evidence that the prior art fails to enable the claimed invention. CHISUM at n. 53. *Chisum* then disagreed with the cited district court opinions and, by analogizing to presumptions in other legal contexts, hypothesized that the Federal Circuit would require a validity challenger to first produce some evidence that a prior art reference is enabling. Thus, Halliburton's argument that it was misled by *Chisum* or even the state of controlling law is unpersuasive; *Chisum* acknowledged the different approaches to the burden of proof on the enabling quality of a prior art reference and gave its best guess on what the Federal Circuit would decide.

Third, even assuming Halliburton was somehow confused or misled as to the controlling law, the illustrative case cited in *Chisum* for the proposition that a validity challenger must first produce some evidence that a reference is enabling states:

> Since the burden is always on the challenger to show invalidity by clear and convincing evidence, once [the accused infringer] has shown that each and every claim is cited in [a cited prior art] reference, i.e., identity, [the patentee] only has the burden of producing some material evidence which places the

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> enablement of the reference in question. Once it has done so, [the accused infringer] must show by clear and convincing evidence that the reference was, in fact, enabling.

CHISUM (internal citations omitted, quoting *Abbott Labs. v. Diamedix Corp.*, 969 F. Supp. 1064 (N.D. Ill. 1997)). Contrary to the relevant case law, Halliburton did not produce some material evidence which placed the enablement of the reference in question. Indeed, it did not even raise this issue in its briefs, rather only in oral argument without evidentiary support.

Fourth, the holding in *Amgen* is not directly on point and thus is not controlling law within the meaning of Rule 59(e). The court and the parties in *Amgen* agreed that under section 282, 35 U.S.C. § 282, the claims of a prior art patent are presumed enabling. Here the claims of the '266 Patent disclose that the tool seals the well bore. *See* '266 Patent, claims 2, 3, and 6. The Federal Circuit in *Amgen* addressed the presumption of enablement in the context of a patent's unclaimed disclosures. Therefore, *Amgen* is not controlling law for the purposes of Rule 59(e). Fifth, *Amgen* did not purport to change the law pertaining to the presumption of enablement for prior art references, rather the Federal Circuit relied on established precedent. *See Amgen,* 314 F.3d at 1355.

Lastly, in applying for the extraordinary remedy of preliminary injunction, Halliburton had the burden of establishing a likelihood of success on the merits. As part of that burden, Halliburton had to show that Weatherford's attack on its patents lacked substantial merit. Notwithstanding this burden, Halliburton failed to raise in its briefs or to produce any evidence on the failure of the '266 Patent as an enabling disclosure. Halliburton cannot now blame Professor Chisum for its failure to offer evidence that the '266 Patent was not

enabling. Halliburton's motion to alter or amend judgment is therefore DENIED.[2]

SIGNED this 26 day of August, 2003.

David C. Godbey, District Judge

[2]In light of this Order, Halliburton's motion for admission of the '266 Model, filed on May 12, 2003, is DENIED, Defendant BJ Services Company's motion to strike, filed April 7, 2003, is DENIED as moot, and Weatherford's motion for leave to file its submission of additional rebuttal evidence in response to Halliburton's motion for reconsideration, filed August 22, 2003, is DENIED as moot.

US005271468A

United States Patent [19]

Streich et al.

[11] Patent Number: 5,271,468
[45] Date of Patent: Dec. 21, 1993

[54] DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

[75] Inventors: Steven G. Streich; Donald F. Hushbeck; Kevin T. Berscheidt; Rick D. Jacobi, all of Duncan, Okla.

[73] Assignee: Halliburton Company, Duncan, Okla.

[21] Appl. No.: 719,740

[22] Filed: Jun. 21, 1991

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 515,019, Apr. 26, 1990, abandoned.

[51] Int. Cl.[5] E21B 33/129
[52] U.S. Cl. 166/387; 166/118; 166/134; 166/217; 166/376; 175/57
[58] Field of Search 166/376, 387, 118, 135, 166/134, 138, 179, 192, 382, 123, 128, 242; 175/57

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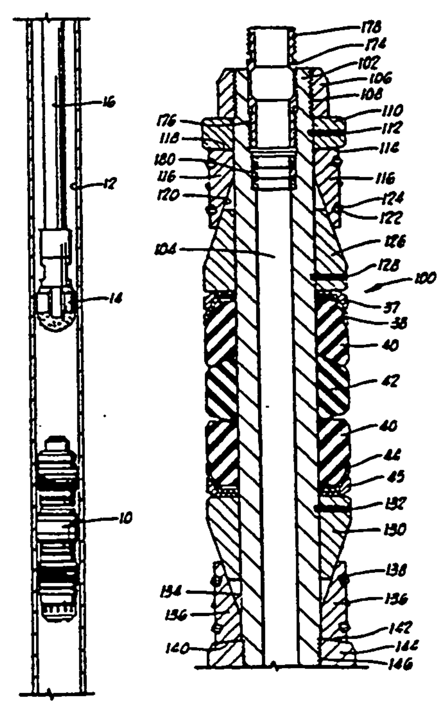
Primary Examiner—Stephen J. Novosad

[57] ABSTRACT

A downhole tool apparatus and methods of drilling the apparatus. The apparatus may include, but is not limited to, packers and bridge plugs utilizing non-metallic components. The material may include engineering grade plastics. The nonmetallic components may include but are not limited to the center mandrel, slips, slip wedges, slip supports and housings, spacer rings, valve housings and valve components. Methods of drilling out the apparatus without significant variations in the drilling speed and weight applied to the drill bit may be employed. Alternative drill bit types, such as polycrystalline diamond compact (PDC) bits may also be used.

75 Claims, 6 Drawing Sheets



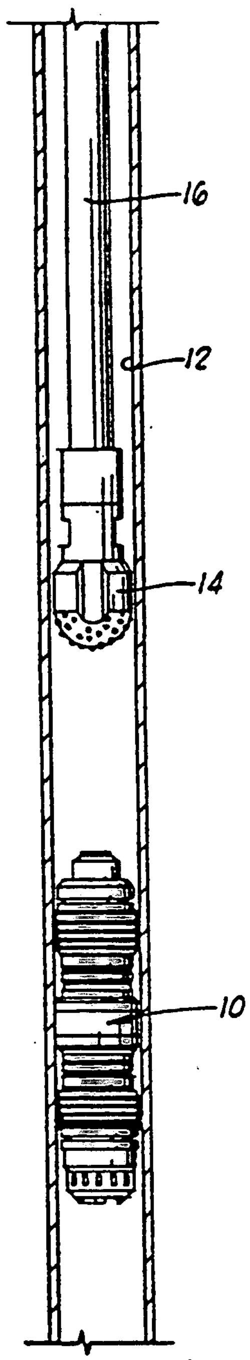

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FIG. 1

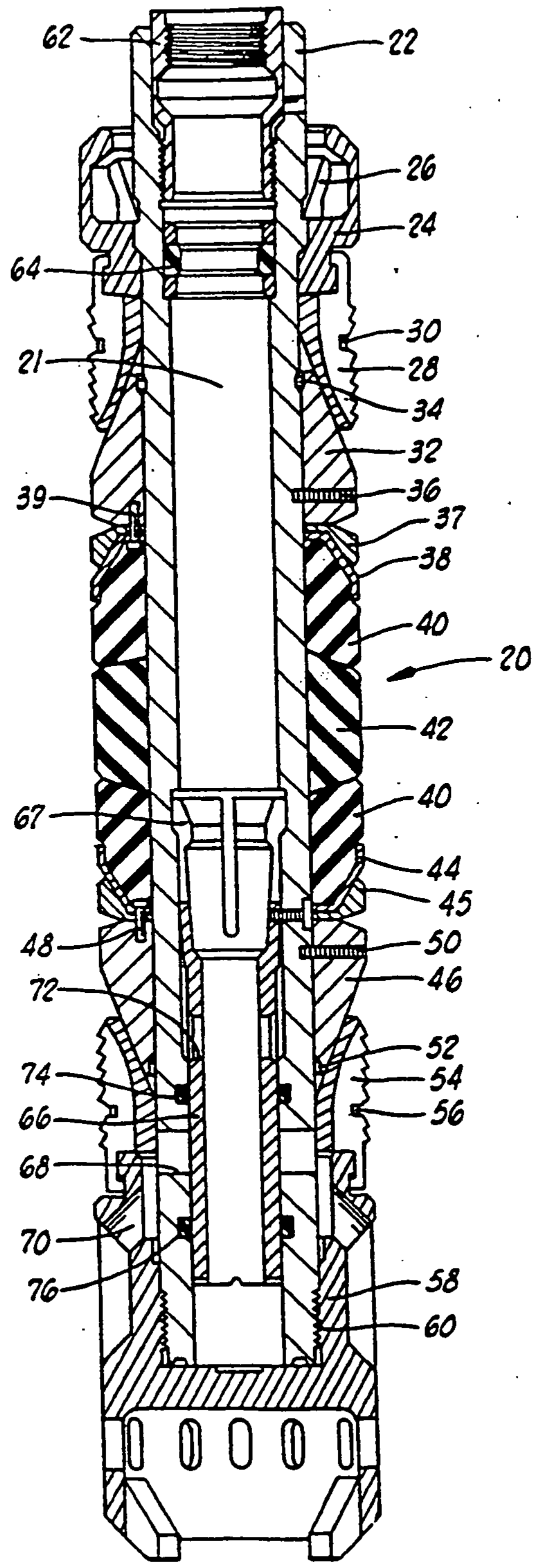
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FIG. 2

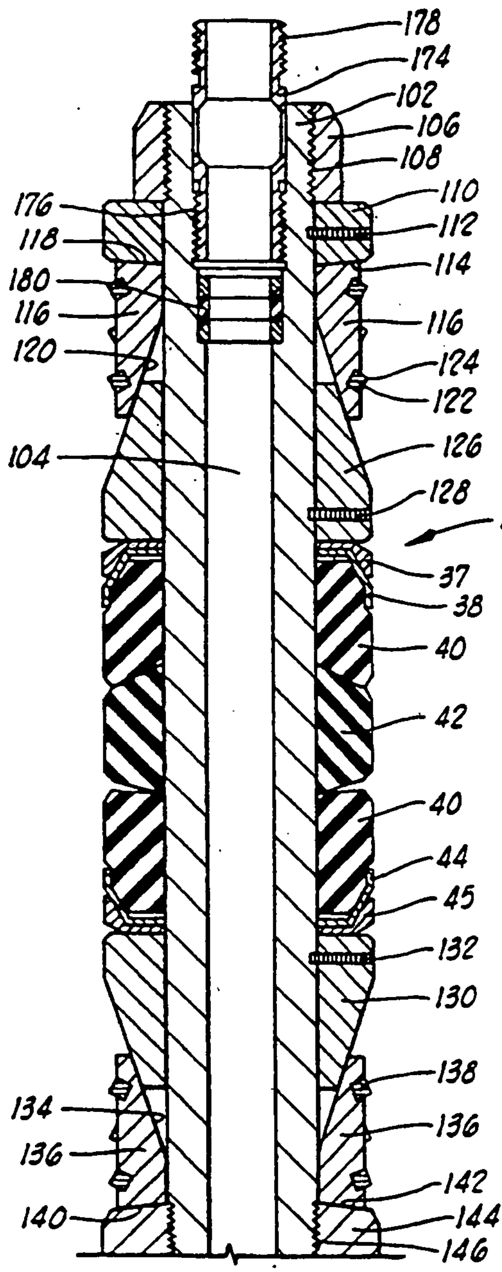
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FIG. 3A

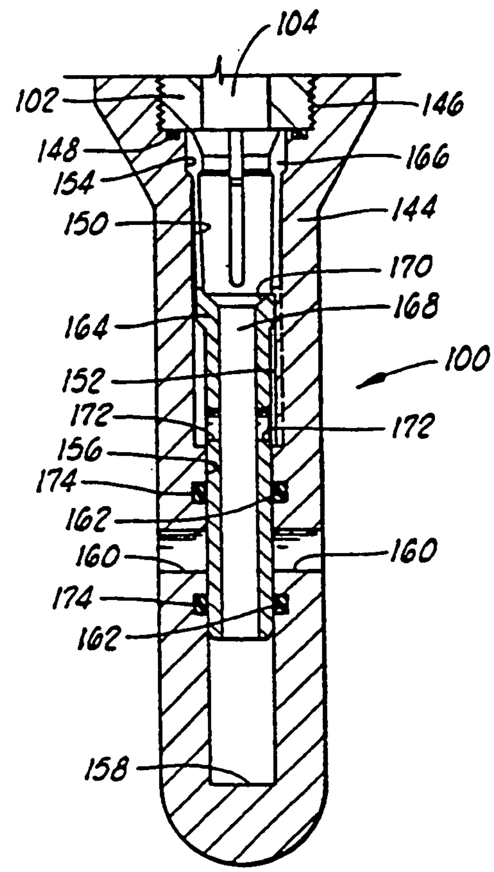
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FIG. 3B

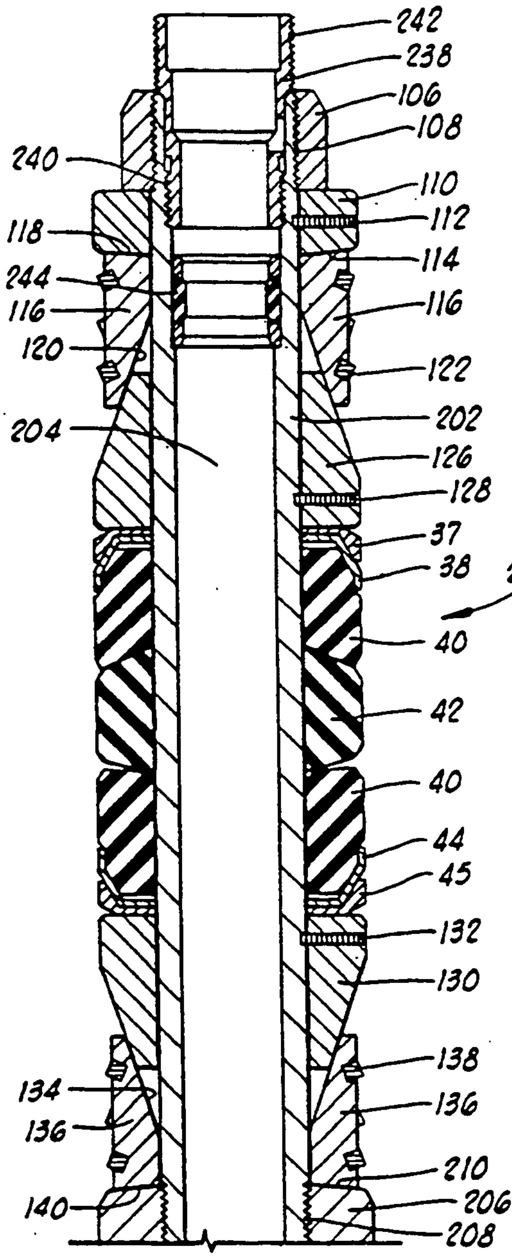
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FIG. 4A

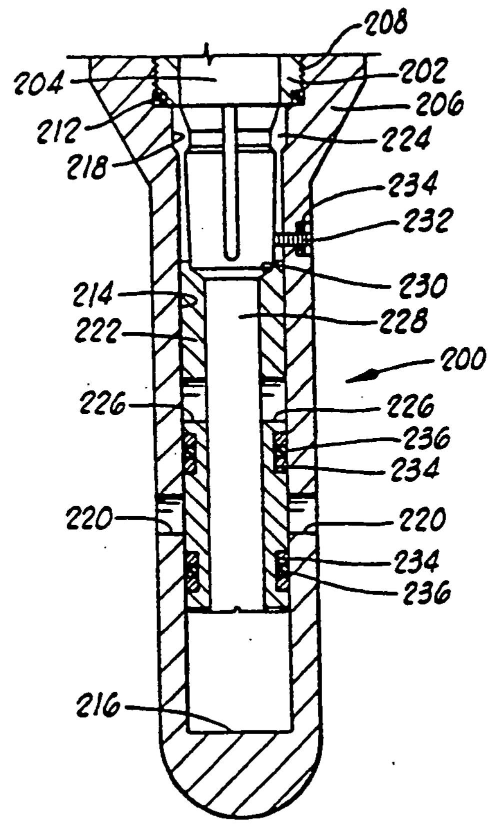
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FIG. 4B

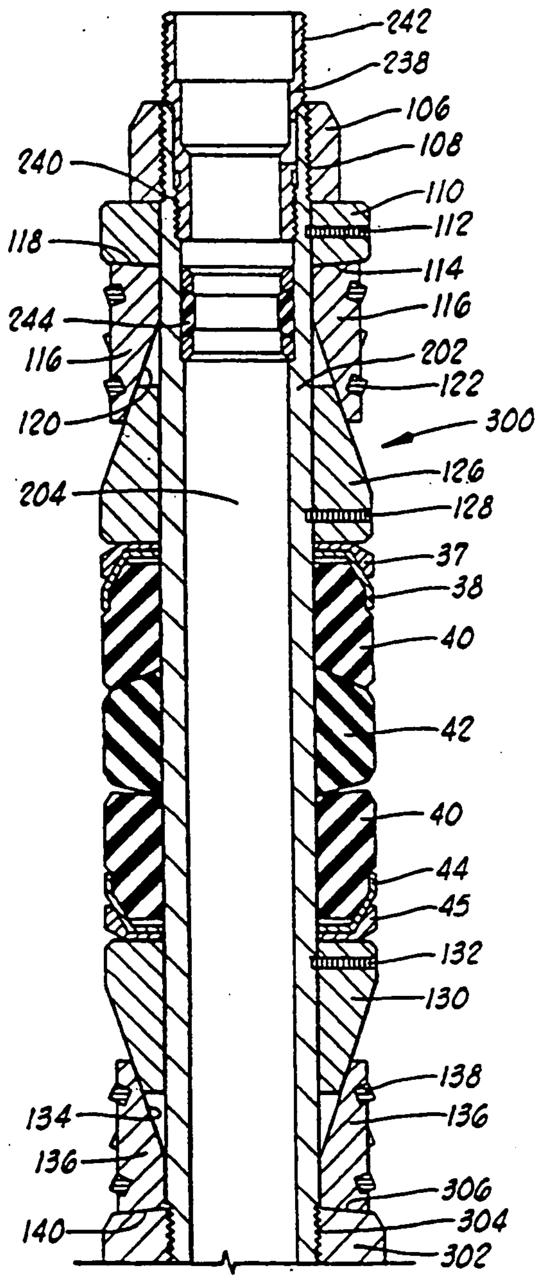
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FIG. 5A

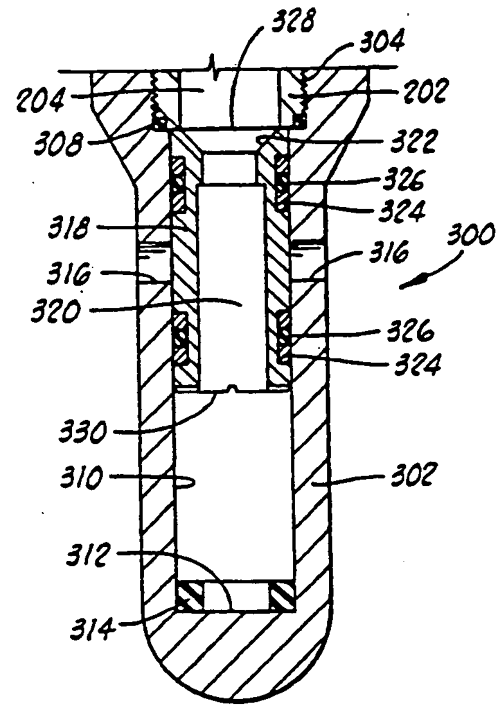
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FIG. 5B

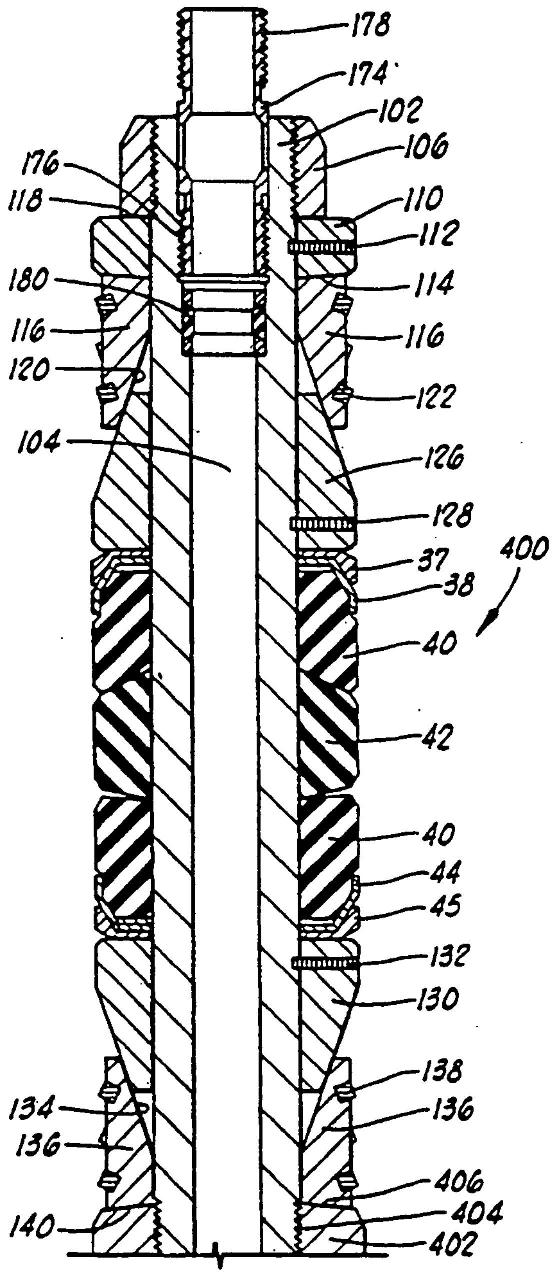
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FIG. 6A

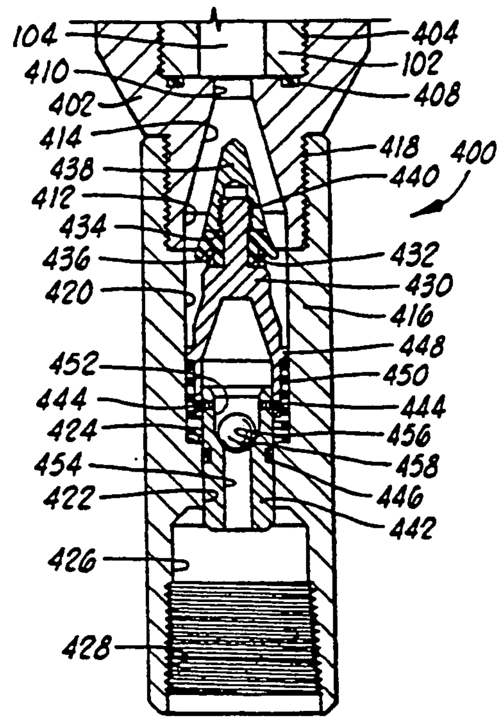
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FIG. 6B

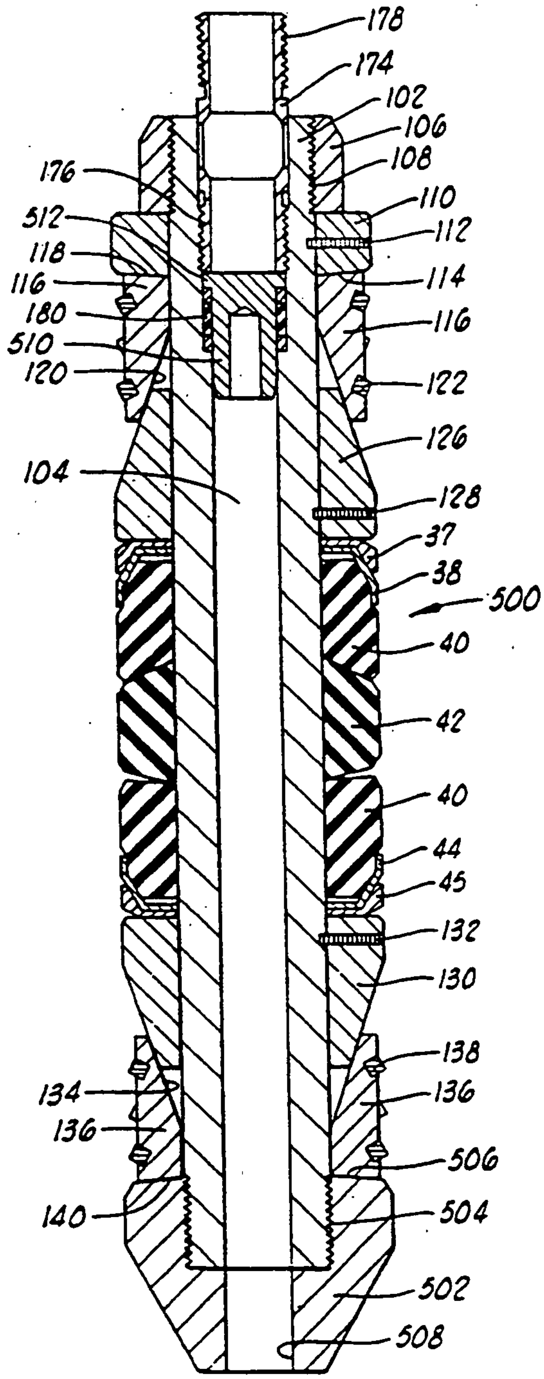
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FIG. 7

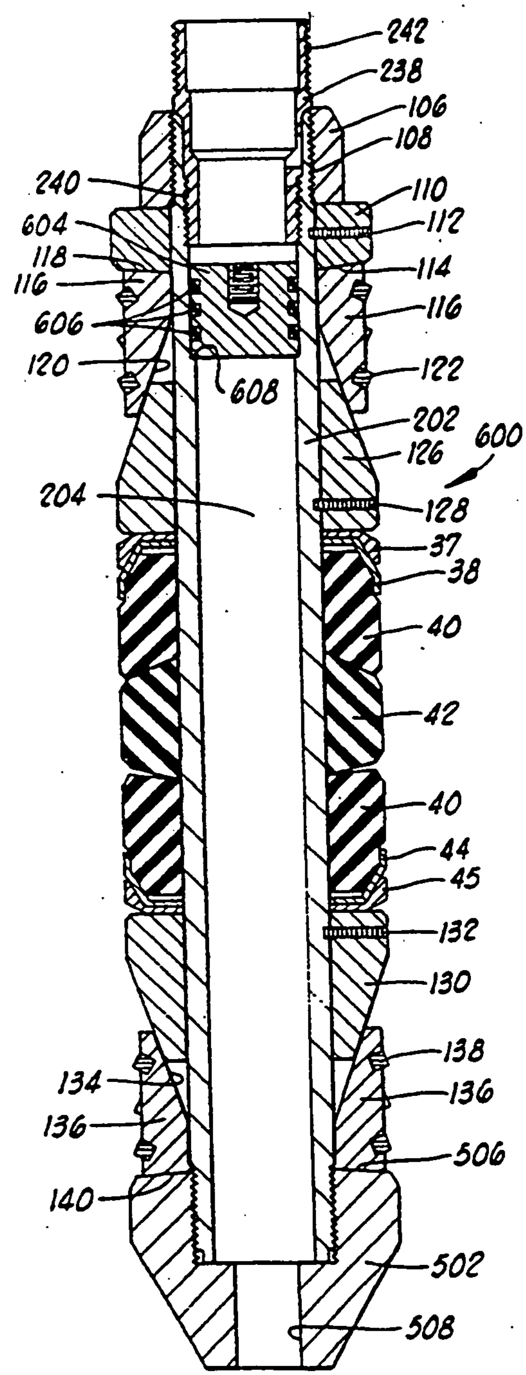
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FIG. 8

DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

This application is a continuation-in-part of co-pending application Ser. No. 07/515,019, filed Apr. 26, 1990 now abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to downhole tools for use in well bores and methods of drilling such apparatus out of well bores, and more particularly, to such tools having drillable components therein made of non-metallic materials, such as engineering grade plastics.

2. Description Of The Prior Art

In the drilling or reworking of oil wells, a great variety of downhole tools are used. For example, but not by way of limitation, it is often desirable to seal tubing or other pipe in the casing of the well, such as when it is desired to pump cement or other slurry down tubing and force the slurry out into a formation. It then becomes necessary to seal the tubing with respect to the well casing and to prevent the fluid pressure of the slurry from lifting the tubing out of the well. Packers and bridge plugs designed for these general purposes are well known in the art.

When it is desired to remove many of these downhole tools from a well bore, it is frequently simpler and less expensive to mill or drill them out rather than to implement a complex retrieving operation. In milling, a milling cutter is used to grind the packer or plug, for example, or at least the outer components thereof, out of the well bore. Milling is a relatively slow process, but it can be used on packers or bridge plugs having relatively hard components such as erosion-resistant hard steel. One such packer is disclosed in U.S. Pat. No. 4,151,875 to Sullaway, assigned to the assignee of the present invention and sold under the trademark EZ Disposal packer. Other downhole tools in addition to packers and bridge plugs may also be drilled out.

In drilling, a drill bit is used to cut and grind up the components of the downhole tool to remove it from the well bore. This is a much faster operation than milling, but requires the tool to be made out of materials which can be accommodated by the drill bit. Typically, soft and medium hardness cast iron are used on the pressure bearing components, along with some brass and aluminum items. Packers of this type include the Halliburton EZ Drill ® and EZ Drill SV ® squeeze packers.

The EZ Drill SV ® squeeze packer, for example, includes a lock ring housing, upper slip wedge, lower slip wedge, and lower slip support made of soft cast iron. These components are mounted on a mandrel made of medium hardness cast iron. The EZ Drill ® squeeze packer is similarly constructed. The Halliburton EZ Drill ® bridge plug is also similar, except that it does not provide for fluid flow therethrough.

All of the above-mentioned packers are disclosed in Halliburton Services Sales and Service Catalog No. 43, pages 2561–2562, and the bridge plug is disclosed in the same catalog on pages 2556–2557.

The EZ Drill ® packer and bridge plug and the EZ Drill SV ® packer are designed for fast removal from the well bore by either rotary or cable tool drilling methods. Many of the components in these drillable packing devices are locked together to prevent their spinning while being drilled, and the harder slips are grooved so that they will be broken up in small pieces. Typically, standard "tri-cone" rotary drill bits are used which are rotated at speeds of about 75 to about 120 rpm. A load of about 5,000 to about 7,000 pounds of weight is applied to the bit for initial drilling and increased as necessary to drill out the remainder of the packer or bridge plug, depending upon its size. Drill collars may be used as required for weight and bit stabilization.

Such drillable devices have worked well and provide improved operating performance at relatively high temperatures and pressures. The packers and plug mentioned above are designed to withstand pressures of about 10,000 psi and temperatures of about 425° F. after being set in the well bore. Such pressures and temperatures require the cast iron components previously discussed.

However, drilling out iron components requires certain techniques. Ideally, the operator employs variations in rotary speed and bit weight to help break up the metal parts and reestablish bit penetration should bit penetration cease while drilling. A phenomenon known as "bit tracking" can occur, wherein the drill bit stays on one path and no longer cuts into the downhole tool. When this happens, it is necessary to pick up the bit above the drilling surface and rapidly recontact the bit with the packer or plug and apply weight while continuing rotation. This aids in breaking up the established bit pattern and helps to reestablish bit penetration. If this procedure is used, there are rarely problems. However, operators may not apply these techniques or even recognize when bit tracking has occurred. The result is that drilling times are greatly increased because the bit merely wears against the surface of the downhole tool rather than cutting into it to break it up.

While cast iron components may be necessary for the high pressures and temperatures for which they are designed, it has been determined that many wells experience pressures less than 10,000 psi and temperatures less than 425° F. This includes most wells cemented. In fact, in the majority of wells, the pressure is less than about 5,000 psi, and the temperature is less than about 250° F. Thus, the heavy duty metal construction of the previous downhole tools, such as the packers and bridge plugs described above, is not necessary for many applications, and if cast iron components can be eliminated or minimized, the potential drilling problems resulting from bit tracking might be avoided as well.

The downhole tool of the present invention solves this problem by providing an apparatus wherein at least some of the components, including pressure bearing components, are made of non-metallic materials, such as engineering grade plastics. Such plastic components are much more easily drilled than cast iron, and new drilling methods may be employed which use alternative drill bits such as polycrystalline diamond compact bits, or the like, rather than standard tri-cone bits.

SUMMARY OF THE INVENTION

The downhole tool apparatus of the present invention utilizes non-metallic materials, such as engineering grade plastics, to reduce weight, to reduce manufacturing time and labor, to improve performance through reducing frictional forces of sliding surfaces, to reduce costs and to improve drillability of the apparatus when drilling is required to remove the apparatus from the well bore. Primarily, in this disclosure, the downhole

tool is characterized by well bore packing apparatus, but it is not intended that the invention be limited to such packing devices. The non-metallic components in the downhole tool apparatus also allow the use of alternative drilling techniques to those previously known.

In packing apparatus embodiments of the present invention, the apparatus may utilize the same general geometric configuration of previously known drillable packers and bridge plugs while replacing at least some of the metal components with non-metallic materials which can still withstand the pressures and temperatures exposed thereto in many well bore applications. In other embodiments of the present invention, the apparatus may comprise specific design changes to accommodate the advantages of plastic materials and also to allow for the reduced strengths thereof compared to metal components.

In one embodiment of the downhole tool, the invention comprises a center mandrel and slip means disposed on the mandrel for grippingly engaging the well bore when in a set position. In packing embodiments, the apparatus further comprises a packing means disposed on the mandrel for sealingly engaging the well bore when in a set position.

The slip means may comprise a wedge engaging a plurality of slips with a slip support on the opposite side of the slips from the wedge. Any of the mandrel, slips, slip wedges or slip supports may be made of the non-metallic material, such as plastic. Specific plastics include nylon, phenolic materials and epoxy resins. The phenolic materials may further include any of Fiberite FM4056J, Fiberite FM4005 or Resinoid 1360. The plastic components may be molded or machined.

One preferred plastic material for at least some of these components is a glass reinforced phenolic resin having a tensile strength of about 18,000 psi and a compressive strength of about 40,000 psi, although the invention is not intended to be limited to this particular plastic or a plastic having these specific physical properties. The plastic materials are preferably selected such that the packing apparatus can withstand well pressures less than about 10,000 psi and temperatures less than about 425° F. In one preferred embodiment, but not by way of limitation, the plastic materials of the packing apparatus are selected such that the apparatus can withstand well pressures up to about 5,000 psi and temperatures up to about 250° F.

Most of the components of the slip means are subjected to substantially compressive loading when in a sealed operating position in the well bore, although some tensile loading may also be experienced. The center mandrel typically has tensile loading applied thereto when setting the packer and when the packer is in its operating position.

One new method of the invention is a well bore process comprising the steps of positioning a downhole tool into engagement with the well bore; prior to the step of positioning, constructing the tool such that a component thereof is made of a non-metallic material; and then drilling the tool out of the well bore. The tool may be selected from the group consisting packers and bridge plugs, but is not limited to these devices.

The component made of non-metallic material, may be one of several such components. The components may be substantially subject to compressive loading. Such components in the tool may include lock ring housings, slips, slip wedges and slip supports. Some components, such as center mandrels of such tools may be substantially subjected to tensile loading.

In another embodiment, the step of drilling is carried out using a polycrystalline diamond compact bit. Regardless of the type of drill bit used, the process may further comprise the step of drilling using a drill bit without substantially varying the weight applied to the drill bit.

In another method of the invention, a well bore process comprises the steps of positioning and setting a packing device in the well bore, a portion of the device being made of engineering grade plastic; contacting the device with well fluids; and drilling out the device using a drill bit having no moving parts such as a polycrystalline diamond compact bit. This or a similar drill bit might have been previously used in drilling the well bore itself, so the process may be said to further comprise the step of, prior to the step of positioning and setting the packer, drilling at least a portion of the well bore using a drill bit such as a polycrystalline diamond compact bit.

In one preferred embodiment, the step of contacting the packer is at a pressure of less than about 5,000 psi and a temperature of less than about 250° F, although higher pressures and temperatures may also be encountered.

It is an important object of the invention to provide a downhole tool apparatus utilizing components made of nonmetallic materials and methods of drilling thereof.

It is another object of the invention to provide a well bore packing apparatus using components made of engineering grade plastic.

An additional object of the invention is to provide a packing apparatus having a valve housing disposed substantially below a lower end of a center mandrel and having a valve in the valve housing below the lower end of the center mandrel.

It is a further object of the invention to provide a packing apparatus which may be drilled by alternate methods to those using standard rotary drill bits.

Additional objects and advantages of the invention will become apparent as the following detailed description of the preferred embodiments is read in conjunction with the drawings which illustrate such preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 generally illustrates the downhole tool of the present invention positioned in a well bore with a drill bit disposed thereabove.

FIG. 2 illustrates a cross section of one embodiment of a drillable packer made in accordance with the invention.

FIGS. 3A and 3B show a cross section of a second embodiment of a drillable packer.

FIGS. 4A and 4B show a third drillable packer embodiment.

FIGS. 5A and 5B illustrate a fourth embodiment of a drillable packer.

FIGS. 6A and 6B show a fifth drillable packer embodiment with a poppet valve therein.

FIG. 7 shows a cross section of one embodiment of a drillable bridge plug made in accordance with the present invention.

FIG. 8 illustrates a second embodiment of a drillable bridge plug.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to FIG. 1, the downhole tool apparatus of the present invention is shown and generally designated by the numeral 10. Apparatus 10, which may include, but is not limited to, packers, bridge plugs, or similar devices, is shown in an operating position in a well bore 12. Apparatus 10 can be set in this position by any manner known in the art such as setting on a tubing string or wire line. A drill bit 14 connected to the end of a tool or tubing string 16 is shown above apparatus 10 in a position to commence the drilling out of apparatus 10 from well bore 12. Methods of drilling will be further discussed herein.

First Packer Embodiment

Referring now to FIG. 2, the details of a first squeeze packer embodiment 20 of apparatus 10 will be described. The size and configuration of packer 20 is substantially the same as the previously mentioned prior art EZ Drill SV® squeeze packer. Packer 20 defines a generally central opening 21 therein.

Packer 20 comprises a center mandrel 22 on which most of the other components are mounted. A lock ring housing 24 is disposed around an upper end of mandrel 22 and generally encloses a lock ring 26.

Disposed below lock ring housing 24 and pivotally connected thereto are a plurality of upper slips 28 initially held in place by a retaining band 30. A generally conical upper slip wedge is disposed around mandrel 22 adjacent to upper slips 30. Upper slip wedge 32 is held in place on mandrel 22 by a wedge retaining ring 34 and a plurality of screws 36.

Adjacent to the lower end of upper slip wedge 32 is an upper back-up ring 37 and an upper packer shoe 38 connected to the upper slip wedge by a pin 39. Below upper packer shoe 38 are a pair of end packer elements 40 separated by center packer element 42. A lower packer shoe 44 and lower back-up ring 45 are disposed adjacent to the lowermost end packer element 40.

A generally conical lower slip wedge 46 is positioned around mandrel 22 adjacent to lower packer shoe 44, and a pin 48 connects the lower packer shoe to the lower slip wedge.

Lower slip wedge 46 is initially attached to mandrel 22 by a plurality of screws 50 and a wedge retaining ring 52 in a manner similar to that for upper slip wedge 32. A plurality of lower slips 54 are disposed adjacent to lower slip wedge 46 and are initially held in place by a retaining band 56. Lower slips 54 are pivotally connected to the upper end of a lower slip support 58. Mandrel 22 is attached to lower slip support 58 at threaded connection 60.

Disposed in mandrel 22 at the upper end thereof is a tension sleeve 62 below which is an internal seal 64. Tension sleeve 62 is adapted for connection with a setting tool (not shown) of a kind known in the art.

A collet-latch sliding valve 66 is slidably disposed in central opening 21 at the lower end of mandrel 22 adjacent to fluid ports 68 in the mandrel. Fluid ports 68 in mandrel 22 are in communication with fluid ports 70 in lower slip housing 58. The lower end of lower slip support 58 is closed below ports 70.

Sliding valve 66 defines a plurality of valve ports 72 which can be aligned with fluid ports 68 in mandrel 22 when sliding valve 66 is in an open position. Thus, fluid can flow through central opening 21.

On the upper end of sliding valve 66 are a plurality of collet fingers 67 which are adapted for latching and unlatching with a valve actuation tool (not shown) of a kind known in the art. This actuation tool is used to open and close sliding valve 66 as further discussed herein. As illustrated in FIG. 2, sliding valve 66 is in a closed position wherein fluid ports 68 are sealed by upper and lower valve seals 74 and 76.

In prior art drillable packers and bridge plugs of this type, mandrel 22 is made of a medium hardness cast iron, and lock ring housing 24, upper slip wedge 32, lower slip wedge 46 and lower slip support 58 are made of soft cast iron for drillability. Most of the other components are made of aluminum, brass or rubber which, of course, are relatively easy to drill. Prior art upper and lower slips 28 and 54 are made of hard cast iron, but are grooved so that they will easily be broken up in small pieces when contacted by the drill bit during a drilling operation.

As previously described, the soft cast iron construction of prior art lock ring housings, upper and lower slip wedges, and lower slip supports are adapted for relatively high pressure and temperature conditions, while a majority of well applications do not require a design for such conditions. Thus, the apparatus of the present invention, which is generally designed for pressures lower than 10,000 psi and temperatures lower than 425° F., utilizes engineering grade plastics for at least some of the components. For example, the apparatus may be designed for pressures up to about 5,000 psi and temperatures up to about 250° F., although the invention is not intended to be limited to these particular conditions.

In first packer embodiment 20, at least some of the previously soft cast iron components of the slip means, such as lock ring housing 24, upper and lower slip wedges 32 and 46 and lower slip support 58 are made of engineering grade plastics. In particular, upper and lower slip wedges 32 and 46 are subjected to substantially compressive loading. Since engineering grade plastics exhibit good strength in compression, they make excellent choices for use in components subjected to compressive loading. Lower slip support 58 is also subjected to substantially compressive loading and can be made of engineering grade plastic when packer 20 is subjected to relative low pressures and temperatures.

Lock ring housing 24 is mostly in compression, but does exhibit some tensile loading. However, in most situations, this tensile loading is minimal, and lock ring housing 24 may also be made of an engineering grade plastic of substantially the same type as upper and lower slip wedges 32 and 46 and also lower slip housing 58.

Upper and lower slips 28 and 54 may also be of plastic in some applications. Hardened inserts for gripping well bore 12 when packer 20 is set may be required as part of the plastic slips. Such construction is discussed in more detail herein for other embodiments of the invention.

Lock ring housing 24, upper slip wedge 32, lower slip wedge 46, and lower slip housing 58 comprise approximately 75% of the cast iron of the prior art squeeze packers. Thus, replacing these components with similar components made of engineering grade plastics will enhance the drillability of packer 20 and reduce the time and cost required therefor.

Mandrel 22 is subjected to tensile loading during setting and operation, and many plastics will not be acceptable materials therefor. However, some engineer-

ing plastics exhibit good tensile loading characteristics, so that construction of mandrel 22 from such plastics is possible. Reinforcements may be provided in the plastic resin as necessary.

EXAMPLE

A first embodiment packer 20 was constructed in which upper slip wedge 32 and lower slip wedge 46 were constructed by molding the parts to size from a phenolic resin plastic with glass reinforcement. The specific material used was Fiberite 4056J manufactured by Fiberite Corporation of Winona, Minn. This material is classified by the manufacturer as a two stage phenolic with glass reinforcement. It has a tensile strength of 18,000 psi and a compressive strength of 40,000 psi.

The test packer 20 held to 8,500 psi without failure to wedges 32 and 46, more than sufficient for most well bore conditions.

Second Packer Embodiment

Referring now to FIGS. 3A and 3B, the details of a second squeeze packer embodiment 100 of packing apparatus 10 are shown. While first embodiment 20 incorporates the same configuration and general components as prior art packers made of metal, second packer embodiment 100 and the other embodiments described herein comprise specific design features to accommodate the benefits and problems of using non-metallic components, such as plastic.

Packer 100 comprises a center mandrel 102 on which most of the other components are mounted. Mandrel 102 may be described as a thick cross-sectional mandrel having a relatively thicker wall thickness than typical packer mandrels, including center mandrel 22 of first embodiment 20. A thick cross-sectional mandrel may be generally defined as one in which the central opening therethrough has a diameter less than about half of the outside diameter of the mandrel. That is, mandrel central opening 104 in central mandrel 102 has a diameter less than about half the outside of center mandrel 102. It is contemplated that a thick cross-sectional mandrel will be required if it is constructed from a material having relatively low physical properties. In particular, such materials may include phenolics and similar plastic materials.

An upper support 106 is attached to the upper end of center mandrel 102 at threaded connection 108. In an alternate embodiment, center mandrel 102 and upper support 106 are integrally formed and there is no threaded connection 108. A spacer ring or upper slip support 110 is disposed on the outside of mandrel 102 just below upper support 106. Spacer ring 110 is initially attached to center mandrel 102 by at least one shear pin 112. A downwardly and inwardly tapered shoulder 114 is defined on the lower side of spacer ring 110.

Disposed below spacer ring 110 are a plurality of upper slips 116. A downwardly and inwardly sloping shoulder 118 forms the upper end of each slip 116. The taper of each shoulder 118 conforms to the taper of shoulder 114 on spacer ring 110, and slips 116 are adapted for sliding engagement with shoulder 114, as will be further described herein.

An upwardly and inwardly facing taper 120 is defined in the lower end of each slip 116. Each taper 120 generally faces the outside of center mandrel 102.

A plurality of hardened inserts or teeth 122 preferably are molded into upper slips 116. In the embodiment shown in FIG. 3A, inserts 122 have a generally square cross section and are positioned at an angle so that a radially outer edge 124 protrudes from the corresponding upper slip 116. Outer edge 124 is adapted for grippingly engaging well bore 112 when packer 100 is set. It is not intended that inserts 122 be of square cross section and have a distinct outer edge 124. Different shapes of inserts may also be used. Inserts 122 can be made of any suitable hardened material.

An upper slip wedge 126 is disposed adjacent to upper slips 116 and engages taper 120 therein. Upper slip wedge 126 is initially attached to center mandrel 102 by one or more shear pins 128.

Below upper slip wedge 126 are upper back-up ring 37, upper packer shoe 38, end packer elements 40 separated by center packer element 42, lower packer shoe 44 and lower back-up ring 45 which are substantially the same as the corresponding components in first embodiment packer 20. Accordingly, the same reference numerals are used.

Below lower back-up ring 45 is a lower slip wedge 130 which is initially attached to center mandrel 102 by a shear pin 132. Preferably, lower slip wedge 130 is identical to upper slip wedge 126 except that it is positioned in the opposite direction.

Lower slip wedge 130 is in engagement with an inner taper 134 in a plurality of lower slips 136. Lower slips 136 have inserts or teeth 138 molded therein, and preferably, lower slips 136 are substantially indentical to upper slips 116.

Each lower slip 136 has a downwardly facing shoulder 140 which tapers upwardly and inwardly. Shoulders 140 are adapted for engagement with a corresponding shoulder 142 defining the upper end of a valve housing 144. Shoulder 142 also tapers upwardly and inwardly. Thus, valve housing 144 may also be considered a lower slip support 144.

Referring now also to FIG. 3B, valve housing 146 is attached to the lower end of center mandrel 102 at threaded connection 146. A sealing means, such as O-ring 148, provides sealing engagement between valve housing 144 and center mandrel 102.

Below the lower end of center mandrel 102, valve housing 104 defines a longitudinal opening 150 therein having a longitudinal rib 152 in the lower end thereof. At the upper end of opening 150 is an annular recess 154.

Below opening 150, valve housing 144 defines a housing central opening including a bore 156 therein having a closed lower end 158. A plurality of transverse ports 160 are defined through valve housing 144 and intersect bore 156. The wall thickness of valve housing 144 is thick enough to accommodate a pair of annular seal grooves 162 defined in bore 156 on opposite sides of ports 160.

Slidably disposed in valve housing 144 below center mandrel 102 is a sliding valve 164. Sliding valve 164 is the same as, or substantially similar to, sliding valve 66 in first embodiment packer 20. At the upper end of sliding valve 164 are a plurality of upwardly extending collet fingers 166 which initially engage recess 154 in valve housing 144. Sliding valve 164 is shown in an uppermost, closed position in FIG. 3B. It will be seen that the lower end of center mandrel 102 prevents further upward movement of sliding valve 164.

Sliding valve 164 defines a valve central opening 168 therethrough which is in communication with central opening 104 in center mandrel 102. A chamfered shoul-

der 170 is located at the upper end of valve central opening 168.

Sliding valve 164 defines a plurality of substantially transverse ports 172 therethrough which intersect valve central opening 168. As will be further discussed herein, ports 172 are adapted for alignment with ports 160 in valve housing 144 when sliding valve 164 is in a downward, open position thereof. Rib 152 fits between a pair of collet fingers 166 so that sliding valve 164 cannot rotate within valve housing 144, thus insuring proper alignment of ports 172 and 160. Rib 152 thus provides an alignment means.

A sealing means, such as O-ring 174, is disposed in each seal groove 162 and provides sealing engagement between sliding valve 164 and valve housing 144. It will thus be seen that when sliding valve 164 is moved downwardly to its open position, O-rings 174 seal on opposite sides of ports 172 in the sliding valve.

Referring again to FIG. 3A, a tension sleeve 174 is disposed in center mandrel 102 and attached thereto to threaded connection 176 Tension sleeve 174 has a threaded portion 178 which extends from center mandrel 102 and is adapted for connection to a standard setting tool (not shown) of a kind known in the art.

Below tension sleeve 174 is an internal seal 180 similar to internal seal 64 in first embodiment 20.

Third Packer Embodiment

Referring now to FIGS. 4A and 4B, a third squeeze packer embodiment of the present invention is shown and generally designated by the numeral 200. It will be clear to those skilled in the art that third embodiment 200 is similar to second packer embodiment 100 but has a couple of significant differences.

Packer 200 comprises a center mandrel 202. Unlike center mandrel 102 in second embodiment 100, center mandrel 202 is a thin cross-sectional mandrel. That is, it may be said that center mandrel 102 has a mandrel central opening 204 with a diameter greater than about half of the outside diameter of center mandrel 202. It is contemplated that thin cross-sectional mandrels, such as center mandrel 202, may be made of materials having relatively higher physical properties, such as epoxy resins.

The external components of third packer embodiment 200 which fit on the outside of center mandrel 202 are substantially identical to the outer components on second embodiment 100, and therefore the same reference numerals are shown in FIG. 4A. In a manner similar to second embodiment packer 100, center mandrel 202 and upper support 106 may be integrally formed so that there is no threaded connection 108.

The lower end of center mandrel 202 is attached to a valve housing 206 at threaded connection 208. On the upper end of valve housing 206 is an upwardly and inwardly tapered shoulder 210 against which shoulder 104 on lower slips 136 are slidably disposed. Thus, valve housing 206 may also be referred to as a lower slip support 206.

Referring now also to FIG. 4B, a sealing means, such as O-ring 212, provides sealing engagement between center mandrel 202 and valve housing 206.

Valve housing 206 defines a housing central opening including a bore 214 therein with a closed lower end 216. At the upper end of bore 214 is an annular recess 218. Valve housing 204 defines a plurality of substantially transverse ports 220 therethrough which intersect bore 214.

Slidably disposed in bore 214 in valve housing 206 is a sliding valve 222. At the upper end of sliding valve 222 are a plurality of collet fingers 224 which initially engage recess 218.

Sliding valve 222 defines a plurality of substantially transverse ports 226 therein which intersect a valve central opening 228 in the sliding valve. Valve central opening 228 is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of central opening 228 is a chamfered shoulder 230.

As shown in FIG. 4B, sliding valve 222 is in an uppermost closed position. It will be seen that the lower end of center mandrel 202 prevents further upward movement of sliding valve 222. When sliding valve 222 is moved downwardly to an open position, ports 226 are substantially aligned with ports 220 in valve housing 206. An alignment means, such as an alignment bolt 232, extends from valve housing 206 inwardly between a pair of adjacent collet fingers 224. A sealing means, such as O-ring 234, provides sealing engagement between alignment bolt 232 and valve housing 206. Alignment bolt 234 prevents rotation of sliding valve 222 within valve housing 204 and insures proper alignment of ports 226 and 220 when sliding valve 222 is in its downwardmost, open position.

The wall thickness of sliding valve 222 is sufficient to accommodate a pair of spaced seal grooves 234 are defined in the outer surface of sliding valve 222, and as seen in FIG. 4B, seal grooves 234 are disposed on opposite sides of ports 220 when sliding valve 222 is in the open position shown. A sealing means, such as seal 236, is disposed in each groove 234 to provide sealing engagement between sliding valve 222 and bore 214 in valve housing 206.

Referring again to FIG. 4A, a tension sleeve 238 is attached to the upper end of center mandrel 202 at threaded connection 240. A threaded portion 242 of tension sleeve 238 extends upwardly from center mandrel 202 and is adapted for engagement with a setting apparatus (not shown) of a kind known in the art.

An internal seal 244 is disposed in the upper end of center mandrel 202 below tension sleeve 238.

Fourth Packer Embodiment

Referring now to FIGS. 5A and 5B, a fourth squeeze packer embodiment is shown and generally designated by the numeral 300. As illustrated, fourth embodiment 300 has the same center mandrel 202, and all of the components positioned on the outside of center mandrel 202 are identical to those in the second and third packer embodiments. Therefore, the same reference numerals are used for these components. Tension sleeve 238 and internal seal 244 positioned on the inside of the upper end of center mandrel 202 are also substantially identical to the corresponding components in third embodiment packer 200 and therefore shown with the same reference numerals.

The difference between fourth packer embodiment 300 and third packer embodiment 200 is that in the fourth embodiment shown in FIGS. 5A and 5B, the lower end of center mandrel 202 is attached to a different valve housing 302 at threaded connection 304. Shoulder 140 on each lower slip 136 slidingly engages an upwardly and inwardly tapered shoulder 306 on the top of valve housing 302. Thus, valve housing 302 may also be referred to as lower slip support 302.

Referring now to FIG. 5B, a sealing means, such as O-ring 308, provides sealing engagement between the lower end of center mandrel 202 and valve housing 302.

Valve housing 302 defines a housing central opening including a bore 310 therein with a closed lower end 312. A bumper seal 314 is disposed adjacent to end 312.

Valve housing 302 defines a plurality of substantially transverse ports 316 therethrough which intersect bore 310. A sliding valve 318 is disposed in bore 310, and is shown in an uppermost, closed position in FIG. 5B. It will be seen that the lower end of center mandrel 202 prevents upward movement of sliding valve 318. Sliding valve 318 defines a valve central opening 320 therethrough which is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of valve central opening 320 in sliding valve 318 is an upwardly facing chamfered shoulder 322.

On the outer surface of sliding valve 318, a pair of spaced seal grooves 324 are defined. In the closed position shown in FIG. 5B, seal grooves 324 are on opposite sides of ports 316 in valve housing 302. A sealing means, such as seal 326, is disposed in each seal groove 324 and provides sealing engagement between sliding valve 318 and bore 310 in valve housing 302.

When sliding valve 318 is opened, as will be further described herein, the sliding valve 318 is moved downwardly such that upper end 328 thereof is below ports 316 in valve housing 302. Downward movement of sliding valve 318 is checked when lower end 330 thereof contacts bumper seal 314. Bumper seal 314 is made of a resilient material which cushions the impact of sliding valve 318 thereon.

Fifth Packer Embodiment

Referring now to FIGS. 6A and 6B, a fifth squeeze packer embodiment is shown and generally designated by the numeral 400. As illustrated, fifth packer embodiment 400 incorporates the same thick cross-sectional center mandrel 102 as does second packer embodiment 100 shown in FIGS. 3A and 3B. Also, the external components positioned on center mandrel 102 are the same as in the second, third and fourth packer embodiments, so the same reference numerals will be used. Further, tension sleeve 174 and internal seal 180 in second embodiment 100 are also incorporated in fifth embodiment 400, and therefore these same reference numerals have also been used.

The difference between fifth packer embodiment 400 and second embodiment 100 is that the lower end of center mandrel 102 is attached to a lower slip support 402 at threaded connection 404. Shoulders 140 on lower slips 136 slidingly engage an upwardly and inwardly tapered shoulder 406 at the upper end of lower slip support 402.

Referring now to FIG. 6B, a sealing means, such as O-ring 408, provides sealing engagement between the lower end of center mandrel 102 and lower slip support 402.

Lower slip support 402 defines a first bore 410 therein and a larger second bore 412 spaced downwardly from the first bore. A tapered seat surface 414 extends between first bore 410 and second bore 412.

The lower end of lower support 402 is attached to a valve housing 416 at threaded connection 418. Valve housing 416 defines a first bore 420 and a smaller second bore 422 therein. An upwardly facing annular shoulder 424 extends between first bore 420 and second bore 422. Below second bore 422, valve housing 416 defines a third bore 426 therein with an internally threaded surface 428 forming a port at the lower end of the valve housing.

Disposed in first bore 420 in valve housing 416 is a valve body 430 with an upwardly facing annular shoulder 432 thereon. An elastomeric valve seal 434 and a valve spacer 436, which provides support for the valve seal, are positioned adjacent to shoulder 432 on valve body 430. A conical valve head 438 is positioned above valve seal 434 and is attached to valve body 430 at threaded connection 440. It will be seen by those skilled in the art that valve seal 434 is adapted for sealing engagement with seat surface 414 in lower slip support 402 when valve body 430 is moved upwardly.

The lower end of valve body 430 is connected to a valve holder 442 by one or more pins 444. Valve holder 442 is disposed in second bore 422 of valve housing 416. A sealing means, such as O-ring 446 provides sealing engagement between valve holder 442 and valve housing 416.

Above shoulder 424 in valve housing 416, valve body 430 has a radially outwardly extending flange 448 thereon. A biasing means, such as spring 450, is disposed between flange 448 and shoulder 424 for biasing valve body 430 upwardly with respect to valve housing 416.

Valve holder 442 defines a first bore 452 and a smaller second bore 454 therein with an upwardly facing chamfered shoulder 456 extending therebetween. A ball 458 is disposed in valve holder 442 and is adapted for engagement with shoulder 456.

First Bridge Plug Embodiment

Referring now to FIG. 7, a first bridge plug embodiment of the present invention is shown and generally designated by the numeral 500. First bridge plug embodiment 500 comprises the same center mandrel 102 and the external components positioned thereon as does the second packer embodiment 100. Therefore, the reference numerals for these components shown in FIG. 7 are the same as in FIG. 3A.

The lower end of center mandrel 102 in first bridge plug embodiment 500 is connected to a lower slip support 502 at threaded connection 504. An upwardly and inwardly tapered shoulder 506 on lower slip support 502 engages shoulders 140 on lower slips 136. As with the other embodiments, slips 136 are adapted for sliding along shoulder 506.

Lower slip support 502 defines a bore 508 therein which is in communication with mandrel central opening 104 in center mandrel 102.

A bridging plug 510 is disposed in the upper portion of mandrel central opening 104 in center mandrel 102 and is sealingly engaged with internal seal 180. A radially outwardly extending flange 512 prevents bridging plug 510 from moving downwardly through center mandrel 102.

Above bridging plug 510 is tension sleeve 174, previously described for second packer embodiment 100.

Second Bridge Plug Embodiment

Referring now to FIG. 8, a second bridge plug embodiment of the present invention is shown and generally designated by the numeral 600. Second bridge plug embodiment 600 uses the same thin cross-sectional mandrel 202 as does third packer embodiment 200 shown in FIG. 4A. Also, the external components positioned on center mandrel 202 are the same as previously de-

scribed, so the same reference numerals are used in FIG. 8.

In second bridge plug embodiment 600, the lower end of center mandrel 202 is attached to the same lower slip support 502 as first bridge plug embodiment 500 at threaded connection 602. It will be seen that bore 508 in lower slip support 502 is in communication with mandrel central opening 204 in center mandrel 202.

A bridging plug 604 is positioned in the upper end of mandrel central opening 204 in center mandrel 202. A shoulder 608 in central opening 204 prevents downward movement of bridging plug 604. A sealing means, such as a plurality of O-rings 606, provide sealing engagement between bridging plug 604 and center mandrel 202.

Tension sleeve 238, previously described, is positioned above bridging plug 604.

Setting And Operation Of The Apparatus

Downhole tool apparatus 10 is positioned in well bore 12 and set into engagement therewith in a manner similar to prior art devices made with metallic components. For example, a prior art apparatus and setting thereof is disclosed in the above-referenced U.S. Pat. No. 4,151,875 to Sullaway. This patent is incorporated herein by reference.

For first packer embodiment 20, the setting tool pulls upwardly on tension sleeve 62, and thereby on mandrel 22, while holding lock ring housing 24. The lock ring housing is thus moved relatively downwardly along mandrel 22 which forces upper slips 28 outwardly and shears screws 36, pushing upper slip wedge 32 downwardly against packer elements 40 and 42. Screws 50 are also sheared and lower slip wedge 46 is pushed downwardly toward lower slip support 58 to force lower slips 54 outwardly. Eventually, upper slips 28 and lower slips 54 are placed in gripping engagement with well bore 12 and packer elements 40 and 42 are in sealing engagement with the well bore. The action of upper slips 28 and 54 prevent packer 20 from being unset. As will be seen by those skilled in the art, pressure below packer 20 cannot force the packer out of well bore 12, but instead, causes it to be even more tightly engaged.

Eventually, in the setting operation, tension sleeve 62 is sheared, so the setting tool may be removed from the well bore.

The setting of second packer embodiment 100, third packer embodiment 200, fourth packer embodiment 300, fifth packer embodiment 400, first bridge plug embodiment 500 and second bridge plug embodiment 600 is similar to that for first packer embodiment 20. The setting tool is attached to either tension sleeve 174 or 238. During setting, the setting tool pushes downwardly on upper slip support 110, thereby shearing shear pin 112. Upper slips 116 are moved downwardly with respect to upper slip wedge 126. Tapers 120 and upper slips 116 slide along upper slip wedge 126, and shoulders 118 on upper slips 116 slide along shoulder 114 on upper slip support 110. Thus, upper slips 116 are moved radially outwardly with respect to center mandrel 102 or 202 such that edges 124 of inserts 122 grippingly well bore 12.

Also during the setting operation, upper slip wedge 126 is forced downwardly, shearing shear pin 128. This in turn causes packer elements 40 and 42 to be squeezed outwardly into sealing engagement with the well bore.

The lifting on center mandrel 102 or 202 causes the lower slip support (valve housing 144 in first packer embodiment 100, valve housing 206 in second packer embodiment 200, valve housing 302 in fourth packer embodiment 300, lower slip support 402 in fifth packer embodiment 400, and lower slip support 502 in first bridge plug embodiment 500 and second bridge plug embodiment 600) to be moved up and lower slips 136 to be moved upwardly with respect to lower slip wedge 130. Tapers 134 in lower slips 136 slide along lower slip wedge 130, and shoulders 140 on lower slips 136 slide along the corresponding shoulder 142, 210, 306, 406, or 506. Thus, lower slips 136 are moved radially outwardly with respect to center mandrel 102 or 202 so that inserts 138 grippingly engage well bore 12.

Also during the setting operation, lower slip wedge 130 is forced upwardly, shearing shear pin 132, to provide additional squeezing force on packer elements 40 and 42.

The engagement of inserts 122 in upper slips 116 and inserts 138 in lower slips 136 with well bore 12 prevent packers 100, 200, 300, 400 and bridge plugs 500, 600 from coming unset.

Once any of packers 20, 100, 200, 300, 400 are set, the valves therein may be actuated in a manner known in the art. Sliding valve 164 in second packer embodiment 126, and sliding valve 22 in third packer embodiment 200 are set in a similar, if not identical manner. Sliding valve 318 in fourth packer embodiment 300 is also set in a similar manner, but does not utilize collets, nor is alignment of sliding valve 318 with respect to ports 316 in valve housing 302 important. Sliding valve 318 is simply moved below ports 316 to open the valve. Bumper seal 314 cushions the downward movement of sliding valve 318, thereby minimizing the possibility of damage to sliding valve 318 or valve housing 302 during an opening operation.

In fifth packer embodiment 400, the valve assembly comprising valve body 432, valve seal 434, valve spacer 436, valve head 438 and valve holder 442 is operated in a manner substantially identical to that of the Halliburton EZ Drill ® squeeze packer of the prior art.

Drilling Out The Packer Apparatus

Drilling out any embodiment of downhole tool 10 may be carried out by using a standard drill bit at the end of tubing string 16. Cable tool drilling may also be used. With a standard "tri-cone" drill bit, the drilling operation is similar to that of the prior art except that variations in rotary speed and bit weight are not critical because the nonmetallic materials are considerably softer than prior art cast iron, thus making tool 10 much easier to drill out. This greatly simplifies the drilling operation and reduces the cost and time thereof.

In addition to standard tri-cone drill bits, and particularly if tool 10 is constructed utilizing engineering grade plastics for the mandrel as well as for slip wedges, slips, slip supports and housings, alternate types of drill bits may be used which would be impossible for tools constructed substantially of cast iron. For example, polycrystalline diamond compact (PDC) bits may be used. Drill bit 14 in FIG. 1 is illustrated as a PDC bit. Such drill bits have the advantage of having no moving parts which can jam up. Also, if the well bore itself was drilled with a PDC bit, it is not necessary to replace it with another or different type bit in order to drill out tool 10.

While specific squeeze packer and bridge plug configurations of packing apparatus 10 has been described herein, it will be understood by those skilled in the art

that other tools may also be constructed utilizing components selected of non-metallic materials, such as engineering grade plastics.

Additionally, components of the various packer embodiments may be interchanged. For example, thick cross-sectional center mandrel 102 may be used with valve housing 206 in second packer embodiment 200 or valve housing 302 in fourth packer embodiment 300. Similarly, thin cross-sectional center mandrel 202 could be used with valve body 144 in second packer embodiment 100 or lower slip support 402 and valve housing 416 in fifth packer embodiment 400. The intent of the invention is to provide devices of flexible design in which a variety of configurations may be used.

It will be seen, therefore, that the downhole tool packer apparatus and methods of drilling thereof of the present invention are well adapted to carry out the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments of the apparatus and various drilling methods have been discussed for the purposes of this disclosure, numerous changes in the arrangement and construction of parts and the steps of the methods may be made by those skilled in the art. In particular, the invention is not intended to be limited to squeeze packers or bridge plugs. All such changes are encompassed within the scope and spirit of the appended claims.

What is claimed is:

1. A well bore process comprising the steps of:

constructing a downhole tool such that a component thereof is made of a non-metallic material, said tool comprising:

a center mandrel; and

a plurality of slips disposed around said mandrel for grippingly engaging a well bore when in a set position;

wherein, at least one of said mandrel and said plurality of slips is said component;

positioning said downhole tool into locking, sealing engagement with said well bore; and

drilling said tool out of said well bore.

2. The process of claim 1 wherein said tool is selected from the group consisting of packers and bridge plugs.

3. The process of claim 1 wherein said component is subject to compressive loading.

4. The process of claim 1 wherein said component is subject to tensile loading.

5. The process of claim 1 wherein said center mandrel defines a central opening therein having a diameter less than about half an outside diameter of said center mandrel.

6. The process of claim 1 wherein said center mandrel defines a central opening therein having a diameter greater than about half the outside diameter of said center mandrel.

7. The process of claim 1 wherein said non-metallic material is plastic.

8. The process of claim 7 wherein said component is molded.

9. The process of claim 7 wherein said plastic is selected from the group consisting of nylon, phenolic material or epoxy resin.

10. The process of claim 9 wherein said plastic is a phenolic material and is selected from the group consisting of Fiberite FM4056J, Fiberite FM4005 or Resinoid 1360.

11. The process of claim 1 wherein said step of drilling is carried out with a polycrystalline diamond compact bit.

12. The process of claim 1 wherein said step of drilling is carried out using a drill bit without substantially varying weight applied to said drill bit.

13. A well bore process comprising the steps of:

positioning and setting a packing device into locked, sealing engagement with a well bore, a portion of said device being made of engineering grade plastic;

contacting said device with well fluids; and

drilling out said device using a polycrystalline diamond compact bit.

14. The process of claim 13 wherein said step of contacting is at a temperature of less than about 250° F.

15. The process of claim 13 wherein said step of contacting is at a pressure of less than about 5,000 psi.

16. The process of claim 13 wherein said portion of said device is at least one of a housing, slip, slip wedge, slip support, and mandrel thereof.

17. The process of claim 13 further comprising the step of, prior to said step of positioning and setting said device, drilling at least a portion of said well bore using a polycrystalline diamond compact bit.

18. The process of claim 13 wherein said step of drilling is carried out without substantially varying weight applied to said bit.

19. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means comprising:

a slip wedge made of a non-metallic material; and

slips made of non-metallic material.

20. The apparatus of claim 19 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

21. The apparatus of claim 20 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means comprising another slip wedge made of a non-metallic material.

22. The apparatus of claim 19 wherein said slip means comprises a slip support made of a non-metallic material.

23. The apparatus of claim 19 further comprising a plurality of hardened inserts molded into said material of said slips.

24. The apparatus of claim 19 wherein said non-metallic material is an engineering grade plastic.

25. The apparatus of claim 24 wherein said plastic is nylon.

26. The apparatus of claim 24 wherein said plastic is a phenolic material.

27. The apparatus of claim 26 wherein said phenolic material is one of Fiberite FM4056J, Fiberite FM4005 and Resinoid 1360.

28. The apparatus of claim 24 wherein said plastic is an epoxy resin.

29. The apparatus of claim 24, wherein said wedge is molded to size.

30. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel made of a non-metallic material; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position.

31. The apparatus of claim 30 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

32. The apparatus of claim 30 wherein said slip means comprises a wedge made of a non-metallic material.

33. The apparatus of claim 30 wherein said slip means comprises slips made of a non-metallic material.

34. The apparatus of claim 30 wherein said non-metallic material is an engineering grade plastic.

35. The apparatus of claim 34 wherein said plastic is nylon.

36. The apparatus of claim 34 wherein said plastic is a phenolic material.

37. The apparatus of claim 36 wherein said phenolic material is Fiberite FM4056J.

38. The apparatus of claim 34 wherein said mandrel is molded to size.

39. The apparatus of claim 34 wherein said mandrel has a central opening defined therethrough having a diameter less than about half an outside diameter of said mandrel.

40. The apparatus of claim 34 wherein said mandrel has a central opening defined therethrough having a diameter greater than about half an outside diameter of said mandrel.

41. The apparatus of claim 34 wherein said plastic is an epoxy resin.

42. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel; and

a plurality of slips disposed around said mandrel for grippingly engaging said well bore when in a set position, said slips being made of a non-metallic material.

43. The apparatus of claim 42 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position; and

wherein some of said slips are disposed above said packing means and some of said slips are disposed below said packing means.

44. The apparatus of claim 42 further comprising a wedge disposed adjacent to said slips, said wedge being made of a non-metallic material.

45. The apparatus of claim 42 wherein said mandrel is made of a non-metallic material.

46. The apparatus of claim 42 wherein said non-metallic material is an engineering grade plastic.

47. The apparatus of claim 46 wherein said plastic material is nylon.

48. The apparatus of claim 46 wherein said plastic is a phenolic material.

49. The apparatus of claim 48 wherein said phenolic material is Fiberite FM4056J.

50. The apparatus of claim 46 wherein said plastic is an epoxy resin.

51. The apparatus of claim 46 wherein said slips are molded of said plastic material.

52. The apparatus of claim 51 further comprising a plurality of hardened inserts molded into said plastic.

53. The apparatus of claim 52 wherein each of said inserts has an edge adapted for grippingly engaging said well bore.

54. A packing apparatus for use in a well bore, said apparatus comprising:

a mandrel made of a non-metallic material;

an upper slip support disposed on said mandrel and made of a non-metallic material;

a plurality of upper slips disposed around said mandrel and substantially made of a non-metallic material;

packing means disposed on said mandrel below said upper slips for sealingly engaging said well bore when in a set position;

a plurality of lower slips disposed around said mandrel below said packing means and substantially made of a non-metallic material; and

a lower slip support attached to said mandrel and made of a non-metallic material.

55. The apparatus of claim 54 wherein said non-metallic material of any of said mandrel, upper slip support, upper slips, lower slips and lower slip support is an engineering grade plastic.

56. The apparatus of claim 55 wherein said plastic is nylon.

57. The apparatus of claim 56 wherein said phenolic material is one of Fiberite FM4056J, Fiberite FM4005 and Resinoid 1360.

58. The apparatus of claim 55 wherein said plastic is a phenolic material.

59. The apparatus of claim 55 wherein said plastic is an epoxy resin.

60. The apparatus of claim 55 wherein any of said mandrel, upper slip support upper slips, lower slips and lower slip support may be molded to size.

61. The apparatus of claim 59 wherein:

said center mandrel defines a mandrel central opening therethrough;

said lower slip support is characterized by a valve housing defining a housing central opening therein and a housing port in communication with said housing central opening; and

further comprising a valve disposed in said housing central opening and providing communication between said port and said mandrel central opening when in an open position, said valve being disposed below a lower end of said mandrel.

62. The apparatus of claim 61 wherein upward movement of said valve is prevented by said mandrel.

63. The apparatus of claim 61 wherein said valve is a sliding valve defining a valve central opening therein and a valve port in communication with said valve central opening, wherein said valve port and said housing port are substantially aligned when said valve is in an open position.

64. The apparatus of claim 63 wherein said valve defines a seal groove therein; and

further comprising sealing means disposed in said seal groove for providing sealing engagement between said valve and said valve housing.

65. The apparatus of claim 63 wherein said valve housing defines a seal groove therein; and

further comprising sealing means disposed in said seal groove for providing sealing engagement between said valve and said valve housing.

66. The apparatus of claim 63 further comprising a bumper seal disposed below said valve for cushioning said valve as said valve is moved to said open position thereof.

67. The apparatus of claim 63 further comprising means for preventing relative rotation between said sliding valve and said valve housing.

68. The apparatus of claim 61 wherein said valve is positioned below said housing port when said valve is in said open position.

69. The apparatus of claim 61 further comprising a poppet type valve disposed in said valve housing for providing communication between said mandrel central opening and said housing port when said valve is in an open position.

70. The apparatus of claim 54 further comprising a bridging plug disposed in said mandrel and sealingly engaged therewith.

71. The apparatus of claim 58 wherein:

said upper slip support has a tapered shoulder on a lower end thereof;

said upper slips have a tapered shoulder on an upper end thereof adapted for sliding engagement with said shoulder on said upper slip support;

said lower slip support has a tapered shoulder on an upper end thereof; and

said lower slips have a tapered shoulder on a lower end thereof adapted for sliding engagement with said shoulder on said lower slip support.

72. The apparatus of claim 54 further comprising a plurality of inserts molded into each of said upper and lower slips, said inserts being made of a hardened material adapted for grippingly engaging said well bore.

73. A downhole apparatus for use in a well bore, said apparatus comprising:

a center mandrel made of a non-metallic material; and

slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means comprising a slip wedge made of a non-metallic material.

74. A downhole apparatus for use in a well bore, said apparatus comprising a slip adapted for grippingly engaging the well bore, said slip being made of a non-metallic, non-elastomeric material.

75. A downhole apparatus for use in a well bore, said apparatus comprising:

a slip adapted for grippingly engaging the well bore, said slip being made of a non-metallic material; and

a hardened insert molded into said slip.

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[54] DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 719,740, Jun. 21, 1991, which is a continuation-in-part of Ser. No. 515,019, Apr. 26, 1990, abandoned.

[51] Int. Cl.[5] E21B 33/129

[52] U.S. Cl. 166/118; 166/123; 166/128; 166/134; 166/382

[58] Field of Search 166/387, 376, 118, 135, 166/138, 179, 192

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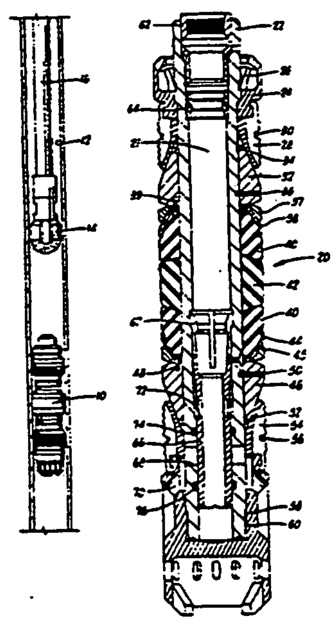
Primary Examiner—Stephen J. Novosad

Attorney, Agent, or Firm—James R. Duzah; Neal R. Kennedy

[57] ABSTRACT

A downhole tool apparatus and methods of drilling the apparatus. The apparatus may include, but is not limited to, packers and bridge plugs utilizing non-metallic slip components. The non-metallic material may include engineering grade plastics. In one embodiment, the slips are separate and held in place in an initial position around the slip wedge by a retainer ring. In another embodiment, the slips are integrally formed with a ring portion which holds the slips in the initial position around the wedge; in this embodiment, the ring portion is made of a fracturable non-metallic material which fractures during a setting operation to separate the slips. Methods of drilling out the apparatus without significant variations in the drilling speed and weight applied to the drill bit may be employed. Alternative drill bit types, such as polycrystalline diamond compact (PDC) bits may also be used.

41 Claims, 7 Drawing Sheets



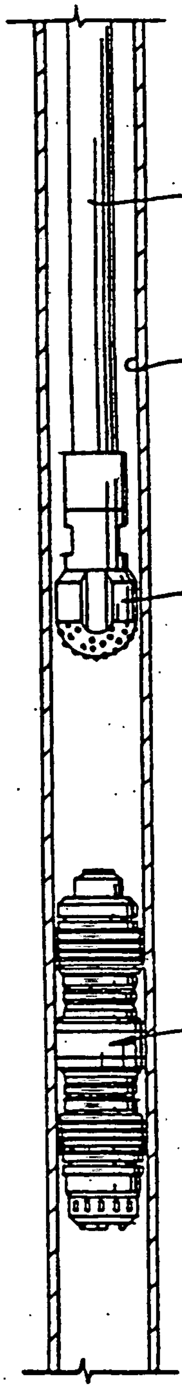

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FIG. 1

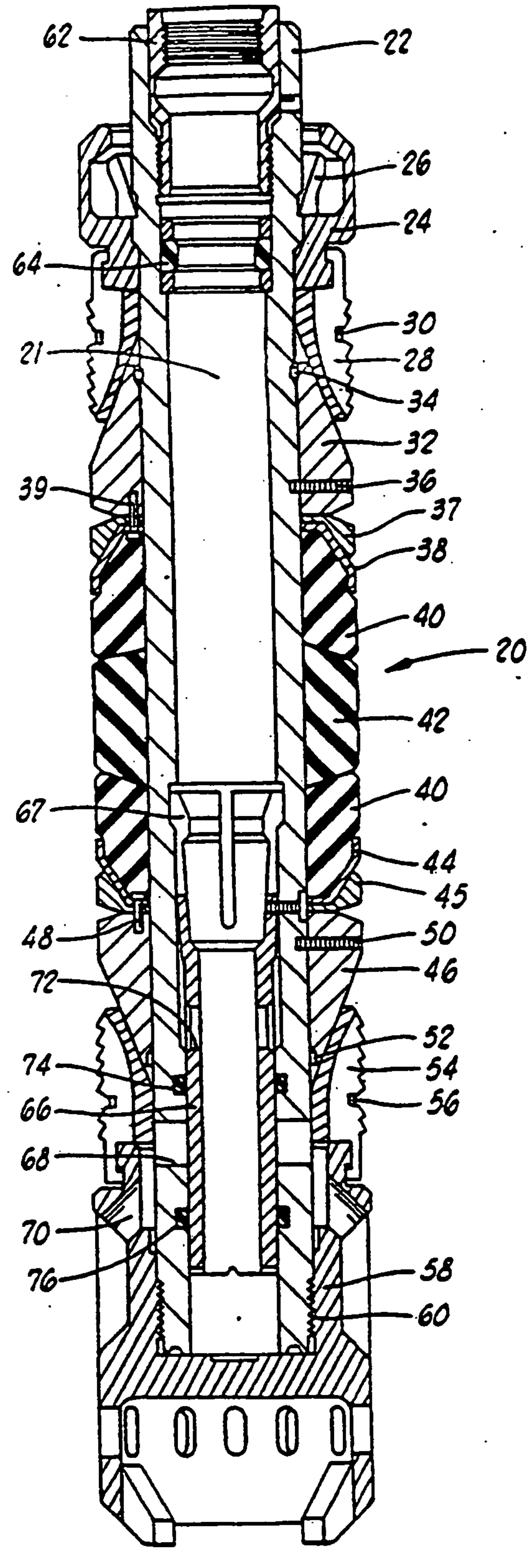
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FIG. 2

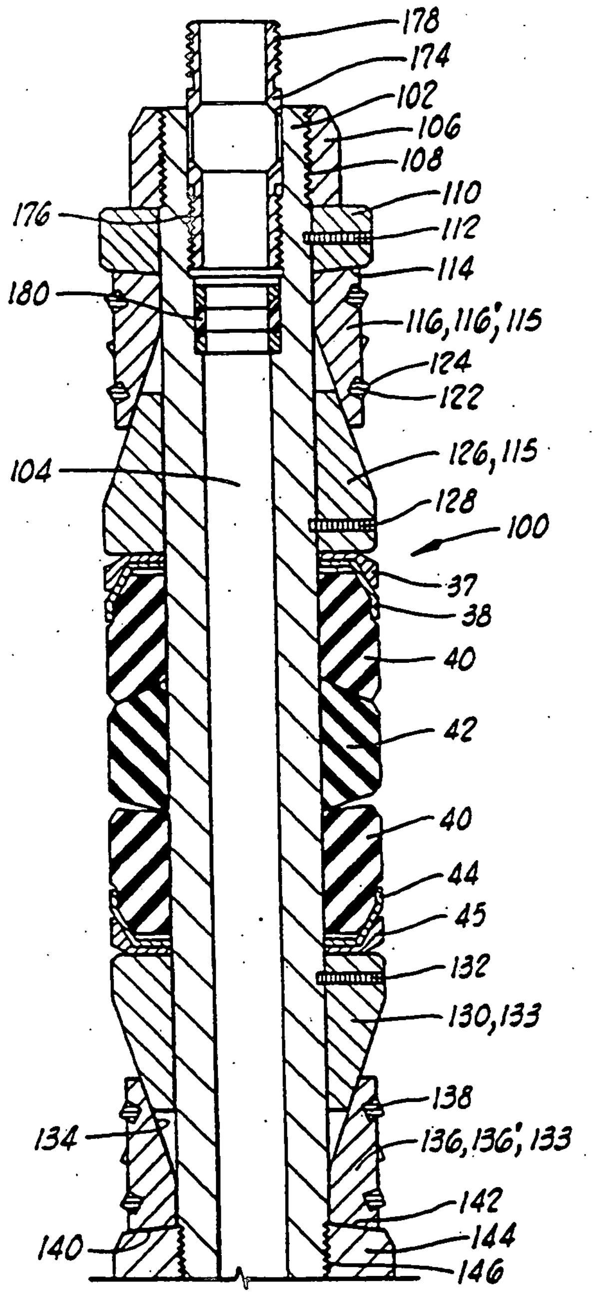
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FIG. 3A

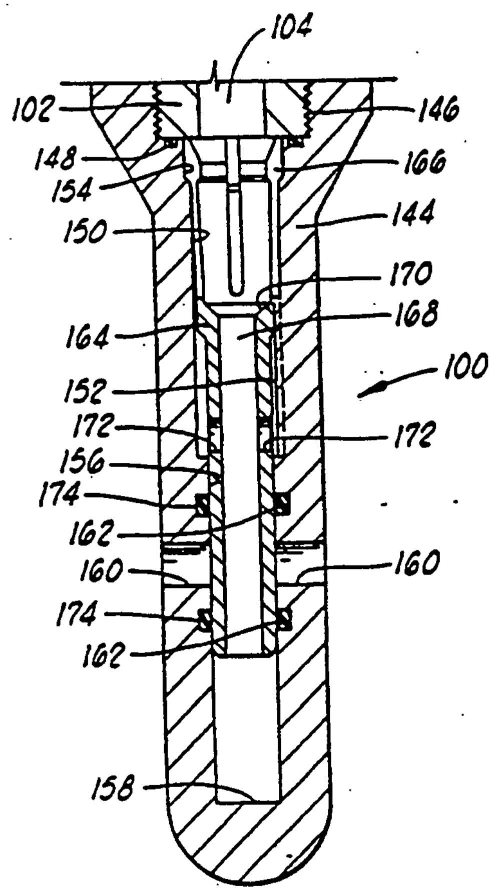
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FIG. 3B

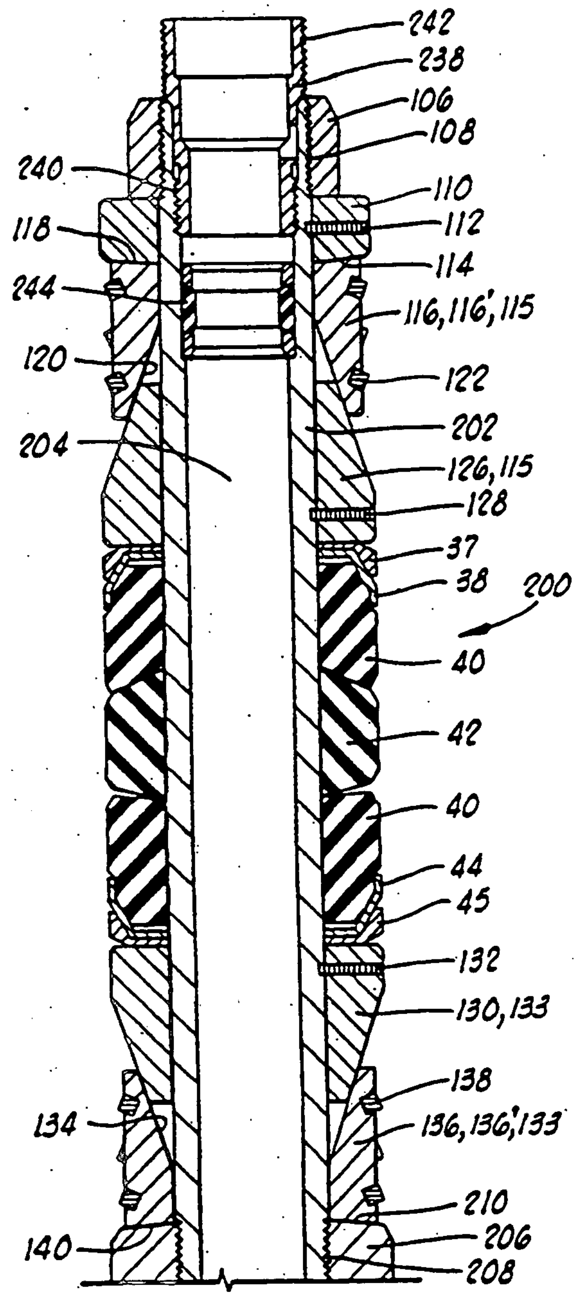
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FIG. 4A

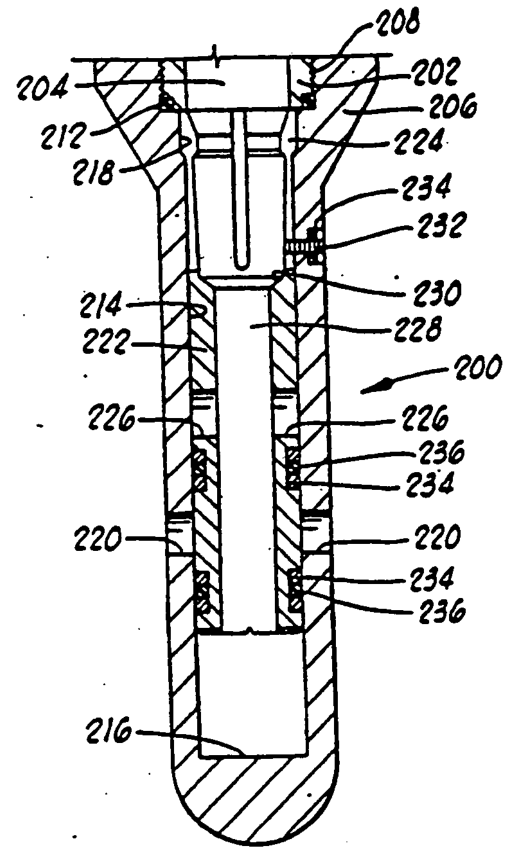
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FIG. 4B

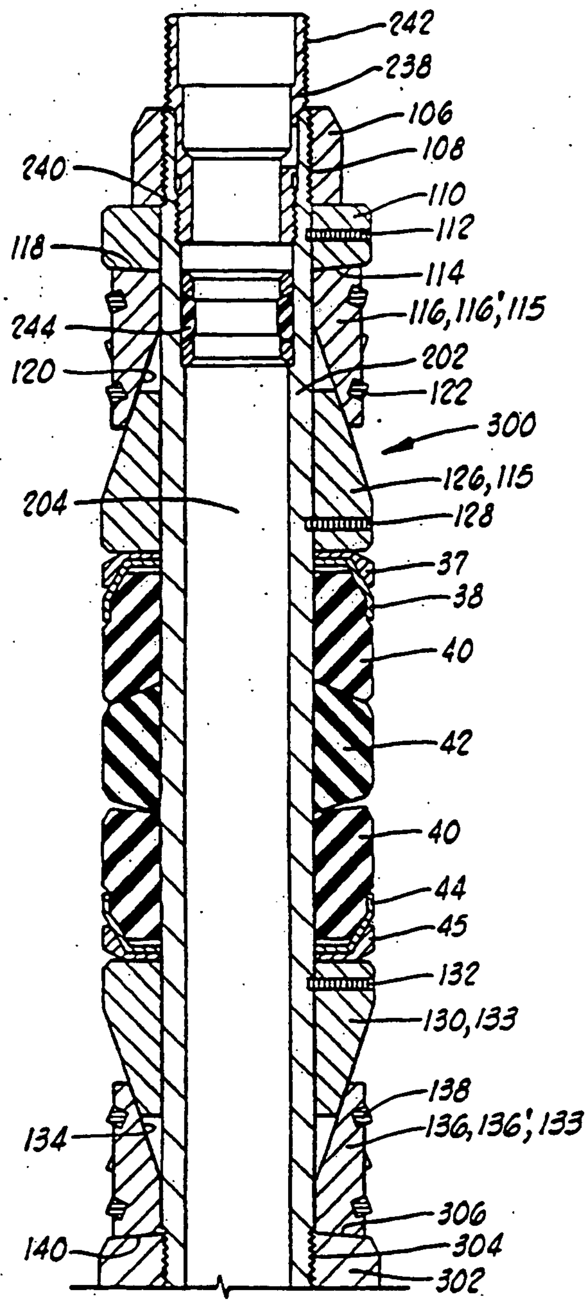
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FIG. 5A

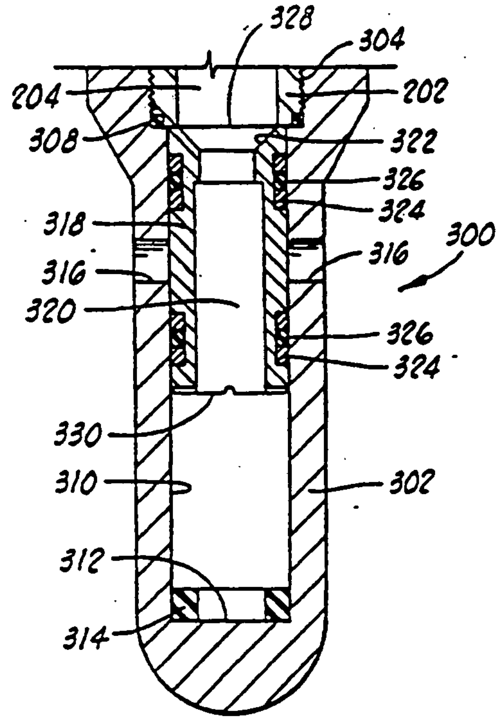
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FIG. 5B

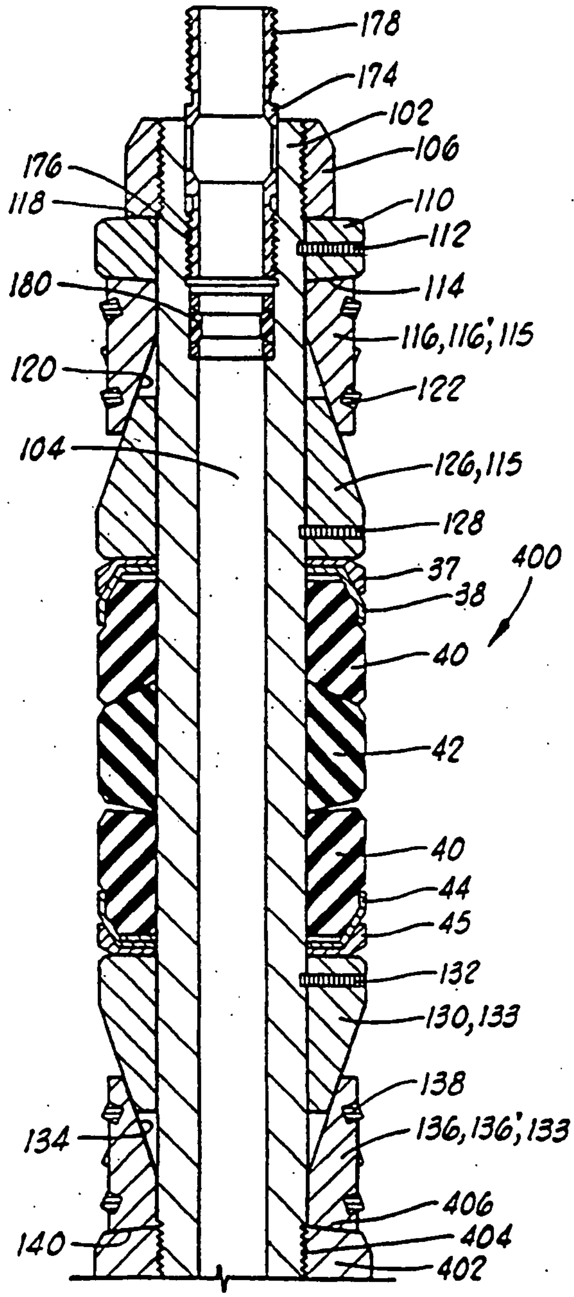
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FIG. 6A

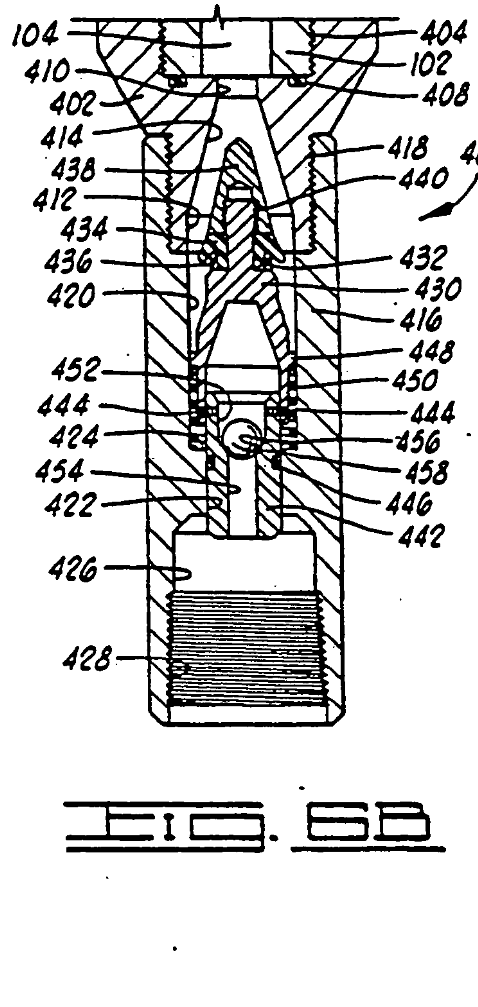
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FIG. 6B

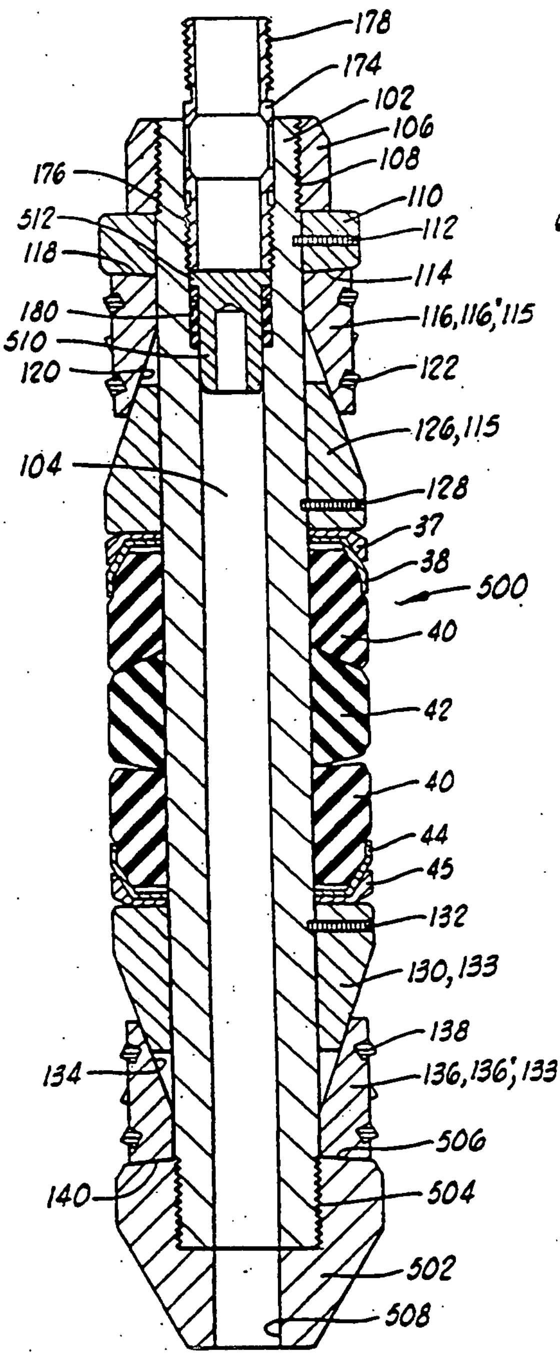
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FIG. 7

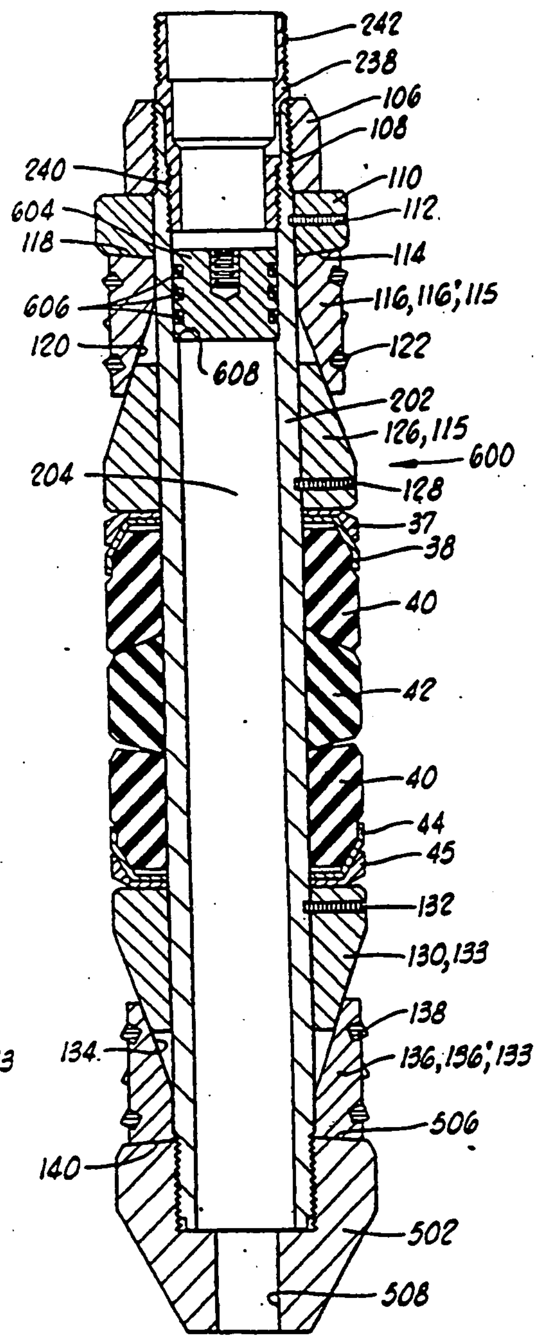
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FIG. 8

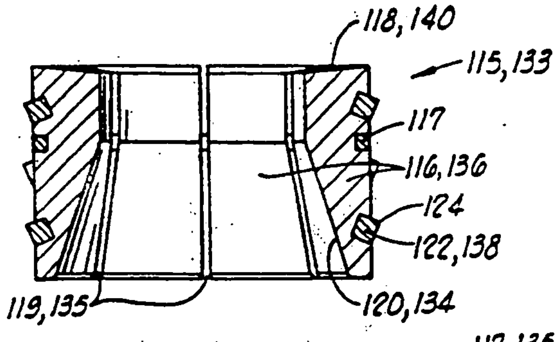

FIG. 9

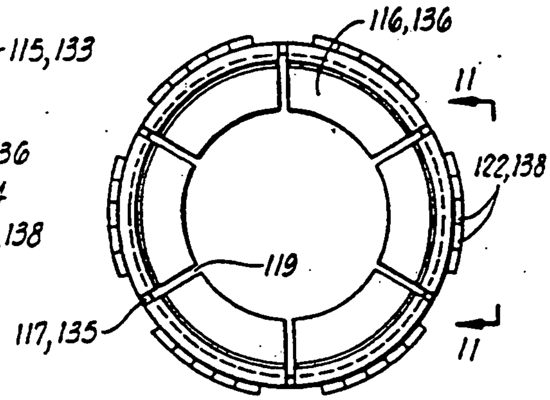

FIG. 10

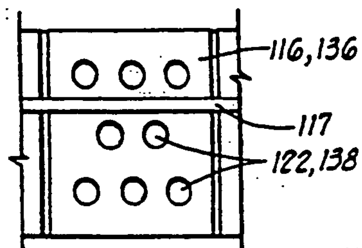

FIG. 11

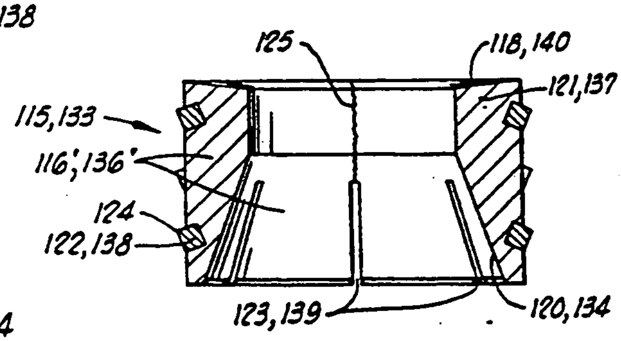

FIG. 12

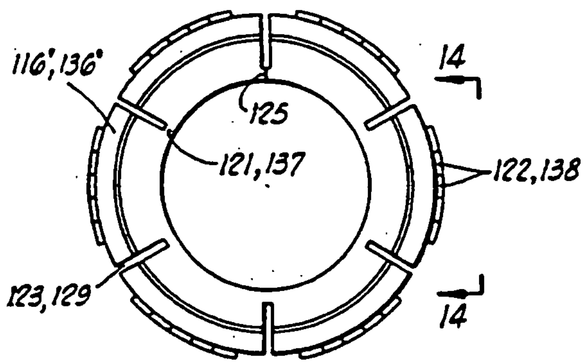

FIG. 13

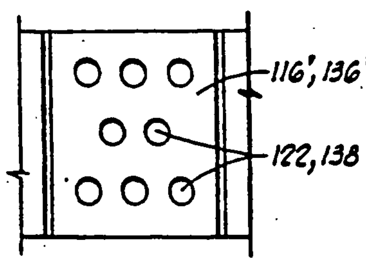

FIG. 14

DOWNHOLE TOOL APPARATUS WITH NON-METALLIC COMPONENTS AND METHODS OF DRILLING THEREOF

This application is a continuation-in-part of co-pending application Ser. No. 07/719,740, filed Jun. 21, 1991, which was a continuation-in-part of application Ser. No. 07/515,019, filed Apr. 26, 1990 and now abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to downhole tools for use in well bores and methods of drilling such apparatus out of well bores, and more particularly, to such tools having drillable components, such as slips, therein made at least partially of non-metallic materials, such as engineering grade plastics.

2. Description Of The Prior Art

In the drilling or reworking of oil wells, a great variety of downhole tools are used. For example, but not by way of limitation, it is often desirable to seal tubing or other pipe in the casing of the well, such as when it is desired to pump cement or other slurry down tubing and force the slurry out into a formation. It then becomes necessary to seal the tubing with respect to the well casing and to prevent the fluid pressure of the slurry from lifting the tubing ou of the well. Packers and bridge plugs designed for these general purposes are well known in the art.

When it is desired to remove many of these downhole tools from a well bore, it is frequently simpler and less expensive to mill or drill them out rather than to implement a complex retrieving operation. In milling, a milling cutter is used to grind the packer or plug, for example, or at least the outer components thereof, out of the well bore. Milling is a relatively slow process, but it can be used on packers or bridge plugs having relatively hard components such as erosion-resistant hard steel. One such packer is disclosed in U.S. Pat. No. 4,151,875 to Sullaway, assigned to the assignee of the present invention and sold under the trademark EZ Disposal packer. Other downhole tools in addition to packers and bridge plugs may also be drilled out.

In drilling, a drill bit is used to cut and grind up the components of the downhole tool to remove it from the well bore. This is a much faster operation than milling, but requires the tool to be made out of materials which can be accommodated by the drill bit. Typically, soft and medium hardness cast iron are used on the pressure bearing components, along with some brass and aluminum items. Packers of this type include the Halliburton EZ Drill ® and EZ Drill SV ® squeeze packers.

The EZ Drill SV ® squeeze packer, for example, includes a lock ring housing, upper slip wedge, lower slip wedge, and lower slip support made of soft cast iron. These components are mounted on a mandrel made of medium hardness cast iron. The EZ Drill ® squeeze packer is similarly constructed. The Halliburton EZ Drill ® bridge plug is also similar, except that it does not provide for fluid flow therethrough.

All of the above-mentioned packers are disclosed in Halliburton Services Sales and Service Catalog No. 43, pages 2561-2562, and the bridge plug is disclosed in the same catalog on pages 2556-2557.

The EZ Drill ® packer and bridge plug and the EZ Drill SV ® packer are designed for fast removal from the well bore by either rotary or cable tool drilling methods. Many of the components in these drillable packing devices are locked together to prevent their spinning while being drilled, and the harder slips are grooved so that they will be broken up in small pieces. Typically, standard "tri-cone" rotary drill bits are used which are rotated at speeds of about 75 to about 120 rpm. A load of about 5,000 to about 7,000 pounds of weight is applied to the bit for initial drilling and increased as necessary to drill out the remainder of the packer or bridge plug, depending upon its size. Drill collars may be used as required for weight and bit stabilization.

Such drillable devices have worked well and provide improved operating performance at relatively high temperature and pressures. The packers and plug mentioned above are designed to withstand pressures of about 10,000 psi and temperatures of about 425° F. after being set in the well bore. Such pressures and temperatures require the cast iron components previously discussed.

However, drilling out iron components requires certain techniques. Ideally, the operator employs variations in rotary speed and bit weight to help break up the metal parts and reestablish bit penetration should bit penetration cease while drilling. A phenomenon known as "bit tracking" can occur, wherein the drill bit stays on one path and no longer cuts into the downhole tool. When this happens, it is necessary to pick up the bit above the drilling surface and rapidly recontact the bit with the packer or plug and apply weight while continuing rotation. This aids in breaking up the established bit pattern and helps to reestablish bit penetration. If this procedure is used, there are rarely problems. However, operators may not apply these techniques or even recognize when bit tracking has occurred. The result is that drilling times are greatly increased because the bit merely wears against the surface of the downhole tool rather than cutting into it to break it up.

While cast iron components may be necessary for the high pressures and temperatures for which they are designed, it has been determined that many wells experience pressures less than 10,000 psi and temperatures less than 425° F. This includes most wells cemented. In fact, in the majority of wells, the pressure is less than about 5,000 psi, and the temperature is less than about 250° F. Thus, the heavy duty metal construction of the previous downhole tools, such as the packers and bridge plugs described above, is not necessary for many applications, and if cast iron components can be eliminated or minimized the potential drilling problems resulting from bit tracking might be avoided as well.

The downhole tool of the present invention solves this problem by providing an apparatus wherein at least some of the components, including slips and pressure bearing components, are made at least partially of non-metallic materials, such as engineering grade plastics. Such plastic components are much more easily drilled than cast iron, and new drilling methods may be employed which use alternative drill bits such as polycrystalline diamond compact bits, or the like, rather than standard tri-cone bits.

SUMMARY OF THE INVENTION

The downhole tool apparatus of the present invention utilizes non-metallic materials, such as engineering grade plastics, to reduce weight, to reduce manufacturing time and labor, to improve performance through

reducing frictional forces of sliding surfaces, to reduce costs and to improve drillability of the apparatus when drilling is required to remove the apparatus from the well bore. Primarily, in this disclosure, the downhole tool is characterized by well bore packing apparatus, but it is not intended that the invention be limited to such packing devices. The non-metallic components in the downhole tool apparatus also allow the use of alternative drilling techniques to those previously known.

In packing apparatus embodiments of the present invention, the apparatus may utilize the same general geometric configuration of previously known drillable packers and bridge plugs while replacing at least some of the metal components with non-metallic materials which can still withstand the pressures and temperatures exposed thereto in many well bore applications. In other embodiments of the present invention, the apparatus may comprise specific design changes to accommodate the advantages of plastic materials and also to allow for the reduced strengths thereof compared to metal components.

In one embodiment of the downhole tool, the invention comprises a center mandrel and slip means disposed on the mandrel for grippingly engaging the well bore when in a set position. In packing embodiments, the apparatus further comprises a packing means disposed on the mandrel for sealingly engaging the well bore when in a set position.

The slips means comprises a slip wedge positioned around the center mandrel, a plurality of slips disposed in an initial position around the mandrel and adjacent to the wedge, retaining means for holding the slips in the initial position, and a slip support on an opposite side of the slips from the wedge. In one embodiment, the slips are separate and the retaining means is characterized by a retaining band extending at least partially around the slips. In another embodiment, the retaining means is characterized by a ring portion integrally formed with the slips. This ring portion is fracturable during a setting operation, whereby the slips are separated so that they can be moved into gripping engagement with the well bore. Hardened inserts may be molded into the slips of either embodiment. The inserts may be metallic, such as hardened steel, or non-metallic, such as ceramic.

Any of the mandrel, slips, slip wedges or slip supports may be made of the non-metallic material, such as plastic. Specific plastics include nylon, phenolic materials and epoxy resins. The phenolic materials may further include any of Fiberite FM4056J, Fiberite FM4005 or Resinoid 1360. The plastic components may be molded or machined.

One preferred plastic material for at least some of these components is a glass reinforced phenolic resin having a tensile strength of about 18,000 psi and a compressive strength of about 40,000 psi, although the invention is not intended to be limited to this particular plastic or a plastic having these specific physical properties. The plastic materials are preferably selected such that the packing apparatus can withstand well pressures less than about 10,000 psi and temperatures less than about 425° F. In one preferred embodiment, but not by way of limitation, the plastic materials of the packing apparatus are selected such that the apparatus can withstand well pressures up to about 5,000 psi and temperatures up to about 250° F.

Most of the components of the slip means are subjected to substantially compressive loading when in a sealed operating position in the well bore, although some tensile loading may also be experienced. The center mandrel typically ha tensile loading applied thereto when setting the packer and when the packer is in its operating position.

One new method of the invention is a well bore process comprising the steps of positioning a downhole tool into engagement with the well bore; prior to the step of positioning, constructing the tool such that a component thereof is made of a non-metallic material; and then drilling the tool out of the well bore. The tool may be selected from the group consisting packers and bridge plugs, but is not limited to these devices.

The component made of non-metallic material, may be one of several such components. The components may be substantially subject to compressive loading. Such components in the tool may include lock ring housings, slips, slip wedges and slip supports. Some components, such as center mandrels of such tools may be substantially subjected to tensile loading.

In another embodiment, the step of drilling is carried out using a polycrystalline diamond compact bit. Regardless of the type of drill bit used, the process may further comprise the step of drilling using a drill bit without substantially varying the weight applied to the drill bit.

In another method of the invention, a well bore process comprises the steps of positioning and setting a packing device in the well bore, a portion of the device being made of engineering grade plastic; contacting the device with well fluids; and drilling out the device using a drill bit having no moving parts such as a polycrystalline diamond compact bit. This or a similar drill bit might have been previously used in drilling the well bore itself, so the process may be said to further comprise the step of, prior to the step of positioning and setting the packer, drilling at least a portion of the well bore using a drill bit such as a polycrystalline diamond compact bit.

In one preferred embodiment, the step of contacting the packer is at a pressure of less than about 5,000 psi and a temperature of less than about 250° F, although higher pressures and temperatures may also be encountered.

It is an important object of the invention to provide a downhole tool apparatus utilizing components, such as slip means, made at least partially of non-metallic materials and methods of drilling thereof.

It is another object of the invention to provide a well bore packing apparatus using slip means components made of engineering grade plastic.

It is a further object of the invention to provide a packing apparatus which may be drilled by alternate methods to those using standard rotary drill bits.

Additional objects and advantages of the invention will become apparent as the following detailed description of the preferred embodiments is read in conjunction with the drawings which illustrate such preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 generally illustrates the downhole tool of the present invention positioned in a well bore with a drill bit disposed thereabove.

FIG. 2 illustrates a cross section of one embodiment of a drillable packer made in accordance with the invention.

FIGS. 3A and 3B show a cross section of a second embodiment of a drillable packer.

FIGS. 4A and 4B show a third drillable packer embodiment.

FIGS. 5A and 5B illustrate a fourth embodiment of a drillable packer.

FIGS. 6A and 6B show a fifth drillable packer embodiment with a poppet valve therein.

FIG. 7 shows a cross section of one embodiment of a drillable bridge plug made in accordance with the present invention.

FIG. 8 illustrates a second embodiment of a drillable bridge plug.

FIG. 9 is a vertical cross section of one preferred embodiment of slips used in the drillable packer and bridge plug of the plug of the present invention.

FIG. 10 is an end view of the slips shown in FIG. 9.

FIG. 11 is an elevational view taken along lines 11—11 in FIG. 10.

FIG. 12 shows a vertical cross section of an alternate embodiment of slips used in the drillable packer and bridge plug of the present invention.

FIG. 13 is an end view of the slips of FIG. 12.

FIG. 14 shows an elevation as seen along lines 14—14 in FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to FIG. 1, the downhole tool apparatus of the present invention is shown and generally designated by the numeral 10. Apparatus 10, which may include, but is not limited to, packers, bridge plugs, or similar devices, is shown in an operating position in a well bore 12. Apparatus 10 can be set in this position by any manner known in the art such as setting on a tubing string or wire line. A drill bit 14 connected to the end of a tool or tubing string 16 is shown above apparatus 10 in a position to commence the drilling out of apparatus 10 from well bore 12. Methods of drilling will be further discussed herein.

First Packer Embodiment

Referring now to FIG. 2, the details of a first squeeze packer embodiment 20 of apparatus 10 will be described. The size and configuration of packer 20 is substantially the same as the previously mentioned prior art EZ Drill SV® squeeze packer. Packer 20 defines a generally central opening 21 therein.

Packer 20 comprises a center mandrel 22 on which most of the other components are mounted. A lock ring housing 24 is disposed around an upper end of mandrel 22 and generally encloses a lock ring 26.

Disposed below lock ring housing 24 and pivotally connected thereto are a plurality of upper slips 28 initially held in place by a retaining means, such as retaining band or ring 30. A generally conical upper slip wedge is disposed around mandrel 22 adjacent to upper slips 30. Upper slip wedge 32 is held in place on mandrel 22 by a wedge retaining ring 34 and a plurality of screws 36.

Adjacent to the lower end of upper slip wedge 32 is an upper back-up ring 37 and an upper packer shoe 38 connected to the upper slip wedge by a pin 39. Below upper packer shoe 38 are a pair of end packer elements 40 separated by center packer element 42. A lower packer shoe 44 and lower back-up ring 45 are disposed adjacent to the lowermost end packer element 40.

A generally conical lower slip wedge 46 is positioned around mandrel 22 adjacent to lower packer shoe 44, and a pin 48 connects the lower packer shoe to the lower slip wedge.

Lower slip wedge 46 is initially attached to mandrel 22 by a plurality of screws 50 and a wedge retaining ring 52 in a manner similar to that for upper slip wedge 32. A plurality of lower slips 54 are disposed adjacent to lower slip wedge 46 and are initially held in place by a retaining means, such as retaining band or ring 56. Lower slips 54 are pivotally connected to the upper end of a lower slip support 58. Mandrel 22 is attached to lower slip support 58 at threaded connection 60.

Disposed in mandrel 22 at the upper end thereof is a tension sleeve 62 below which is an internal seal 64. Tension sleeve 62 is adapted for connection with a setting tool (not shown) of a kind known in the art.

A collet-latch sliding valve 66 is slidably disposed in central opening 21 at the lower end of mandrel 22 adjacent to fluid ports 68 in the mandrel. Fluid ports 68 in mandrel 22 are in communication with fluid ports 70 in lower slip housing 58. The lower end of lower slip support 58 is closed below ports 70.

Sliding valve 66 defines a plurality of valve ports 72 which can be aligned with fluid ports 68 in mandrel 22 when sliding valve 66 is in an open position. Thus, fluid can flow through central opening 21.

On the upper end of sliding valve 66 are a plurality of collet fingers 67 which are adapted for latching and unlatching with a valve actuation tool (not shown) of a kind known in the art. This actuation tool is used to open and close sliding valve 66 as further discussed herein. As illustrated in FIG. 2, sliding valve 66 is in a closed position wherein fluid ports 68 are sealed by upper and lower valve seals 74 and 76.

In prior art drillable packers and bridge plugs of this type, mandrel 22 is made of a medium hardness cast iron, and lock ring housing 24, upper slip wedge 32, lower slip wedge 46 and lower slip support 58 are made of soft cast iron for drillability. Most of the other components are made of aluminum, brass or rubber which, of course, are relatively easy to drill. Prior art upper and lower slips 28 and 54 are made of hard cast iron, but are grooved so that they will easily be broken up in small pieces when contacted by the drill bit during a drilling operation.

As previously described, the soft cast iron construction of prior art lock ring housings, upper and lower slip wedges, and lower slip supports are adapted for relatively high pressure and temperature conditions, while a majority of well applications do not require a design for such conditions. Thus, the apparatus of the present invention, which is generally designed for pressures lower than 10,000 psi and temperatures lower than 425° F., utilizes engineering grade plastics for at least some of the components. For example, the apparatus may be designed for pressures up to about 5,000 psi and temperatures up to about 250° F., although the invention is not intended to be limited to these particular conditions.

In first packer embodiment 20, at least some of the previously soft cast iron components of the slip means, such as lock ring housing 24, upper and lower slip wedges 32 and 46 and lower slip support 58 are made of engineering grade plastics. In particular, upper and lower slip wedges 32 and 46 are subjected to substantially compressive loading. Since engineering grade plastics exhibit good strength in compression, they make excellent choices for use in components subjected to compressive loading. Lower slip support 58 is also subjected to substantially compressive loading and can

be made of engineering grade plastic when packer 20 is subjected to relative low pressures and temperatures.

Lock ring housing 24 is mostly in compression, but does exhibit some tensile loading. However, in most situations, this tensile loading is minimal, and lock ring housing 24 may also be made of an engineering grade plastic of substantially the same type as upper and lower slip wedges 32 and 46 and also lower slip housing 58.

Upper and lower slips 28 and 54 are illustrated in FIG. 2 as having a conventional configuration. However, non-metallic materials may be used, and thus upper and lower slips 28 and 54 may be made of plastic, for example, in some applications. Hardened inserts for gripping well bore 12 when packer 20 is set may be required as part of the plastic slips. New embodiments of slips utilizing such non-metallic materials will be described later herein.

Lock ring housing 24, upper slip wedge 32, lower slip wedge 46, and lower slip housing 58 comprise approximately 75% of the cast iron of the prior art squeeze packers. Thus, replacing these components with similar components made of engineering grade plastics will enhance the drillability of packer 20 and reduce the time and cost required therefor.

Mandrel 22 is subjected to tensile loading during setting and operation, and many plastics will not be acceptable materials therefor. However, some engineering plastics exhibit good tensile loading characteristics, so that construction of mandrel 22 from such plastics is possible. Reinforcements may be provided in the plastic resin as necessary.

Example

A first embodiment packer 20 was constructed in which upper slip wedge 32 and lower slip wedge 46 were constructed by molding the parts to size from a phenolic resin plastic with glass reinforcement. The specific material used was Fiberite 4056J manufactured by Fiberite Corporation of Winona, Minn. This material is classified by the manufacturer as a two stage phenolic with glass reinforcement. It has a tensile strength of 18.000 psi and a compressive strength of 40.000 psi.

The test packer 20 held to 8,500 psi without failure to wedges 32 and 46, more than sufficient for most well bore conditions.

Second Packer Embodiment

Referring now to FIGS. 3A and 3B, the details of a second squeeze packer embodiment 100 of packing apparatus 10 are shown. While first embodiment 20 incorporates the same configuration and general components as prior art packers made of metal, second packer embodiment 100 and the other embodiments described herein comprise specific design features to accommodate the benefits and problems of using non-metallic components, such as plastic.

Packer 100 comprises a center mandrel 102 on which most of the other components are mounted. Mandrel 102 may be described as a thick cross-sectional mandrel having a relatively thicker wall thickness than typical packer mandrels, including center mandrel 22 of first embodiment 20. A thick cross-sectional mandrel may be generally defined as one in which the central opening therethrough has a diameter less than about half of the outside diameter of the mandrel. That is, mandrel central opening 104 in central mandrel 102 has a diameter less than about half the outside of center mandrel 102. It is contemplated that a thick cross-sectional mandrel will be required if it is constructed from a material having relatively low physical properties. In particular, such materials may include phenolics and similar plastic materials.

An upper support 106 is attached to the upper end of center mandrel 102 at threaded connection 108. In an alternate embodiment, center mandrel 102 and upper support 106 are integrally formed and there is no threaded connection 108. A spacer ring or upper slip support 110 is disposed on the outside of mandrel 102 just below upper support 106. Spacer ring 110 is initially attached to center mandrel 102 by at least one shear pin 112. A downwardly and inwardly tapered shoulder 114 is defined on the lower side of spacer ring 110.

Disposed below spacer ring 110 is an upper slip means 115 comprising slips and a wedge. Referring now to FIGS. 9–11, a new embodiment of upper slip means 115 is characterized as comprising a plurality of separate non-metallic upper slips 116 held in place by a retaining means, such as retaining band or ring 117 extending at least partially around slips 116. Upper slips 116 may be held in place by other types of retaining means as well, such as pins. Slips 116 are preferably circumferentially spaced such that a longitudinally extending gap 119 is defined therebetween.

Each slip 116 has a downwardly and inwardly sloping shoulder 118 forming the upper end thereof. The taper of each shoulder 118 conforms to the taper of shoulder 114 on spacer ring 110, and slips 116 are adapted for sliding engagement with shoulder 114, as will be further described herein.

An upwardly and inwardly facing taper 120 is defined in the lower end of each slip 116. Each taper 120 generally faces the outside of center mandrel 102.

Referring now to FIGS. 12–14, an alternate embodiment of the slips of upper slip means 115 is shown. In this embodiment, a plurality of upper slips 116, are integrally formed at the upper ends thereof such that a ring portion 121 is formed. Ring portion 121 may be considered a retaining means for holding upper slips 116' in their initial position around center mandrel 102. The lower ends of slips 116' extend from ring portion 121 and are circumferentially separated by a plurality of longitudinally extending gaps 123. That is, in the second embodiment upper slip means 115 is a characterized as comprising a single piece molded or otherwise formed from a non-metallic material, such as plastic.

Each slip 116', like each slip 116, has downwardly and inwardly sloping shoulder 118 forming the upper end thereof and generally defined in ring portion 121. Again, the taper of each shoulder 118 conforms to the taper of shoulder 114 on spacer ring 110, and slips 116' are adapted for sliding engagement with shoulder 114, as will be further described herein.

As with slips 116, an upwardly and inwardly facing taper 120 is defined in the lower end of each slip 116'. As before, each taper 120 generally faces the outside of center mandrel 102.

A plurality of inserts or teeth 122 preferably are molded into upper slips 116 or 116'. Inserts 122 may have a generally cylindrical configuration and are positioned at an angle with respect to a central axis of packer 100. Thus, a radially outer edge 124 of each insert 122 protrudes from the corresponding upper slip 116 or 116'. Outer edge 124 is adapted for grippingly engaging well bore 12 when packer 100 is set. It is not intended that inserts 122 be limited to this cylindrical

shape or that they have a distinct outer edge 124. Various shapes of inserts may be used.

Inserts 122 can be made of any suitable hard material. For example, inserts 122 could be hardened steel or a non-metallic hardened material, such as ceramic.

Upper slip means 115 further comprises an upper slip wedge 126 which is disposed adjacent to upper slips 116 or 116' and engages taper 120 therein. Upper slip wedge 126 is initially attached to center mandrel 102 by one or more shear pins 128.

Below upper slip wedge 126 are upper back-up ring 37, upper packer shoe 38, end packer elements 40 separated by center packer element 42, lower packer shoe 44 and lower back-up ring 45 which are substantially the same as the corresponding components in first embodiment packer 20. Accordingly, the same reference numerals are used.

Below lower back-up ring 45 is a lower slip means 133 comprising a lower slip wedge 130 which is initially attached to center mandrel 102 by a shear pin 132. Preferably, lower slip wedge 130 is identical to upper slip wedge 126 except that it is positioned in the opposite direction.

In one new embodiment, lower slip means 133 is characterized as also comprising a plurality of separate non-metallic lower slips 136. Lower slips 136 are preferably identical to upper slips 116, except for a reversal of position, and are initially held in place by retaining means, such as retainer band or ring 117 which extends at least partially around slips 136. Other types of retainer means, such as pins, may also be used to hold slip lower slips 136 in place. Lower slips are preferably circumferentially spaced such that longitudinally extending gaps 135 are defined therebetween. See FIGS. 9-11.

In another embodiment, lower slip means 133 comprises a plurality of lower slips 136' which are integrally formed at the lower ends thereof such that a ring portion 137 is formed. Ring portion 137 may be considered a retaining means for holding lower slips 136' in their initial position around center mandrel 102. It will be seen that lower slips 136' are preferably identical to upper slips 116', except for a reversal in position. See FIGS. 12-14. At the upper ends thereof, slips 136' are circumferentially separated by plurality of longitudinally extending gaps 139.

A downwardly and inwardly facing inner taper 134 in each lower slip 136 or 136' is in engagement with lower slip wedge 130.

Lower slips 136 or 136' have inserts or teeth 138 molded therein which are preferably identical to inserts 122 in upper slips 116 or 116'.

Each lower slip 136 or 136' has a downwardly facing shoulder 140 defined in ring portion 137 which tapers upwardly and inwardly. Shoulders 140 are adapted for engagement with a corresponding shoulder 142 defining the upper end of a valve housing 144. Shoulder 142 also tapers upwardly and inwardly. Thus, valve housing 144 may also be considered a lower slip support 144.

Referring now also to FIG. 3B, valve housing 146 is attached to the lower end of center mandrel 102 at threaded connection 146. A sealing means, such as O-ring 148, provides sealing engagement between valve housing 144 and center mandrel 102.

Below the lower end of center mandrel 102, valve housing 104 defines a longitudinal opening 150 therein having a longitudinal rib 152 in the lower end thereof. At the upper end of opening 150 is an annular recess 154.

Below opening 150, valve housing 144 defines a housing central opening including a bore 156 therein having a closed lower end 158. A plurality of transverse ports 160 are defined through valve housing 144 and intersect bore 156. The wall thickness of valve housing 144 is thick enough to accommodate a pair of annular seal grooves 162 defined in bore 156 on opposite sides of ports 160.

Slidably disposed in valve housing 144 below center mandrel 102 is a sliding valve 164. Sliding valve 164 is the same as, or substantially similar to, sliding valve 66 in first embodiment packer 20. At the upper end of sliding valve 164 are a plurality of upwardly extending collet fingers 166 which initially engage recess 154 in valve housing 144. Sliding valve 164 is shown in an uppermost, closed position in FIG. 3B. It will be seen that the lower end of center mandrel 102 prevents further upward movement of sliding valve 164.

Sliding valve 164 defines a valve central opening 168 therethrough which is in communication with central opening 104 in center mandrel 102. A chamfered shoulder 170 is located at the upper end of valve central opening 168.

Sliding valve 164 defines a plurality of substantially transverse ports 172 therethrough which intersect valve central opening 168. As will be further discussed herein, ports 172 are adapted for alignment with ports 160 in valve housing 144 when sliding valve 164 is in a downward, open position thereof. Rib 152 fits between a pair of collet fingers 166 so that sliding valve 164 cannot rotate within valve housing 144, thus insuring proper alignment of ports 172 and 160. Rib 152 thus provides an alignment means.

A sealing means, such as O-ring 174, is disposed in each seal groove 162 and provides sealing engagement between sliding valve 164 and valve housing 144. It will thus be seen that when sliding valve 164 is moved downwardly to its open position, O-rings 174 seal on opposite sides of ports 172 in the sliding valve.

Referring again to FIG. 3A, a tension sleeve 174 is disposed in center mandrel 102 and attached thereto to threaded connection 176. Tension sleeve 174 has a threaded portion 178 which extends from center mandrel 102 and is adapted for connection to a standard setting tool (not shown) of a kind known in the art.

Below tension sleeve 174 is an internal seal 180 similar to internal seal 64 in first embodiment 20.

Third Packer Embodiment

Referring now to FIGS. 4A and 4B, a third squeeze packer embodiment of the present invention is shown and generally designated by the numeral 200. It will be clear to those skilled in the art that third embodiment 200 is similar to second packer embodiment 100 but has a couple of significant differences.

Packer 200 comprises a center mandrel 202. Unlike center mandrel 102 in second embodiment 100, center mandrel 202 is a thin cross-sectional mandrel. That is, it may be said that center mandrel 102 has a mandrel central opening 204 with a diameter greater than about half of the outside diameter of center mandrel 202. It is contemplated that thin cross-sectional mandrels, such as center mandrel 202, may be made of materials having relatively higher physical properties, such as epoxy resins.

The external components of third packer embodiment 200 which fit on the outside of center mandrel 202 are substantially identical to the outer components on second embodiment 100, and therefore the same reference numerals are shown in FIG. 4A. In a manner similar to second embodiment packer 100, center mandrel 202 and upper support 106 may be integrally formed so that there is no threaded connection 108.

The lower end of center mandrel 202 is attached to a valve housing 206 at threaded connection 208. On the upper end of valve housing 206 is an upwardly and inwardly tapered shoulder 210 against which shoulder 104 on lower slips 136 or 136' are slidably disposed. Thus, valve housing 206 may also be referred to as a lower slip support 206.

Referring now also to FIG. 4B, a sealing means, such as O-ring 212, provides sealing engagement between center mandrel 202 and valve housing 206.

Valve housing 206 defines a housing central opening including a bore 214 therein with a closed lower end 216. At the upper end of bore 214 is an annular recess 218. Valve housing 204 defines a plurality of substantially transverse ports 220 therethrough which intersect bore 214.

Slidably disposed in bore 214 in valve housing 206 is a sliding valve 222. At the upper end of sliding valve 222 are a plurality of collet fingers 224 which initially engage recess 218.

Sliding valve 222 defines a plurality of substantially transverse ports 226 therein which intersect a valve central opening 228 in the sliding valve. Valve central opening 228 is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of central opening 228 is a chamfered shoulder 230.

As shown in FIG. 4B, sliding valve 222 is in an uppermost closed position. It will be seen that the lower end of center mandrel 202 prevents further upward movement of sliding valve 222. When sliding valve 222 is moved downwardly to an open position, ports 226 are substantially aligned with ports 220 in valve housing 206. An alignment means, such as an alignment bolt 232, extends from valve housing 206 inwardly between a pair of adjacent collet fingers 224. A sealing means, such as O-ring 234, provides sealing engagement between alignment bolt 232 and valve housing 206. Alignment bolt 234 prevents rotation of sliding valve 222 within valve housing 204 and insures proper alignment of ports 226 and 220 when sliding valve 222 is in its downwardmost, open position.

The wall thickness of sliding valve 222 is sufficient to accommodate a pair of spaced seal grooves 234 are defined in the outer surface of sliding valve 222, and as seen in FIG. 4B, seal grooves 234 are disposed on opposite sides of ports 220 when sliding valve 222 is in the open position shown. A sealing means, such as seal 236, is disposed in each groove 234 to provide sealing engagement between sliding valve 222 and bore 214 in valve housing 206.

Referring again to FIG. 4A, a tension sleeve 238 is attached to the upper end of center mandrel 202 at threaded connection 240. A threaded portion 242 of tension sleeve 238 extends upwardly from center mandrel 202 and is adapted for engagement with a setting apparatus (not shown) of a kind known in the art.

An internal seal 244 is disposed in the upper end of center mandrel 202 below tension sleeve 238.

Fourth Packer Embodiment

Referring now to FIGS. 5A and 5B, a fourth squeeze packer embodiment is shown and generally designated by the numeral 300. As illustrated, fourth embodiment 300 has the same center mandrel 202, and all of the components positioned on the outside of center mandrel 202 are identical to those in the second and third packer embodiments. Therefore, the same reference numerals are used for these components. Tension sleeve 238 and internal seal 244 positioned on the inside of the upper end of center mandrel 202 are also substantially identical to the corresponding components in third embodiment packer 200 and therefore shown with the same reference numerals.

The difference between fourth packer embodiment 300 and third packer embodiment 200 is that in the fourth embodiment shown in FIGS. 5A and 5B, the lower end of center mandrel 202 is attached to a different valve housing 302 at threaded connection 304. Shoulder 140 on each lower slip 136 or 136' slidingly engages an upwardly and inwardly tapered shoulder 306 on the top of valve housing 302. Thus, valve housing 302 may also be referred to as lower slip support 302.

Referring now to FIG. 5B, a sealing means, such as O-ring 308, provides sealing engagement between the lower end of center mandrel 202 and valve housing 302.

Valve housing 302 defines a housing central opening including a bore 310 therein with a closed lower end 312. A bumper seal 314 is disposed adjacent to end 312.

Valve housing 302 defines a plurality of substantially transverse ports 316 therethrough which intersect bore 310. A sliding valve 318 is disposed in bore 310, and is shown in an uppermost, closed position in FIG. 5B. It will be seen that the lower end of center mandrel 202 prevents upward movement of sliding valve 318. Sliding valve 318 defines a valve central opening 320 therethrough which is in communication with mandrel central opening 204 in center mandrel 202. At the upper end of valve central opening 320 in sliding valve 318 is an upwardly facing chamfered shoulder 322.

On the outer surface of sliding valve 318, a pair of spaced seal grooves 324 are defined. In the closed position shown in FIG. 5B, seal grooves 324 are on opposite sides of ports 316 in valve housing 302. A sealing means, such as seal 326, is disposed in each seal groove 324 and provides sealing engagement between sliding valve 318 and bore 310 in valve housing 302.

When sliding valve 318 is opened, as will be further described herein, the sliding valve 318 is moved downwardly such that upper end 328 thereof is below ports 316 in valve housing 302. Downward movement of sliding valve 318 is checked when lower end 330 thereof contacts bumper seal 314. Bumper seal 314 is made of a resilient material which cushions the impact of sliding valve 31 thereon.

Fifth Packer Embodiment

Referring now to FIGS. 6A and 6B, a fifth squeeze packer embodiment is shown and generally designated by the numeral 400. As illustrated, fifth packer embodiment 400 incorporates the same thick cross-sectional center mandrel 102 as does second packer embodiment 100 shown in FIGS. 3A and 3B. Also, the external components positioned on center mandrel 102 are the same as in the second, third and fourth packer embodiments, so the same reference numerals will be used.

Further, tension sleeve 174 and internal seal 180 in second embodiment 100 are also incorporated in fifth embodiment 400, and therefore these same reference numerals have also been used.

The difference between fifth packer embodiment 400 and second embodiment 100 is that the lower end of center mandrel 102 is attached to a lower slip support 402 at threaded connection 404. Shoulders 140 on lower slips 136 or 136' slidingly engage an upwardly and inwardly tapered shoulder 406 at the upper end of lower slip support 402.

Referring now to FIG. 6B, a sealing means, such as O-ring 408, provides sealing engagement between the lower end of center mandrel 102 and lower slip support 402.

Lower slip support 402 defines a first bore 410 therein and a larger second bore 412 spaced downwardly from the first bore. A tapered seat surface 414 extends between first bore 410 and second bore 412.

The lower end of lower support 402 is attached to a valve housing 416 at threaded connection 418. Valve housing 416 defines a first bore 420 and a smaller second bore 422 therein. An upwardly facing annular shoulder 424 extends between first bore 420 and second bore 422. Below second bore 422, valve housing 416 defines a third bore 426 therein with an internally threaded surface 428 forming a port at the lower end of the valve housing.

Disposed in first bore 420 in valve housing 416 is a valve body 430 with an upwardly facing annular shoulder 432 thereon. An elastomeric valve seal 434 and a valve spacer 436, which provides support for the valve seal, are positioned adjacent to shoulder 432 on valve body 430. A conical valve head 438 is positioned above valve seal 434 and is attached to valve body 430 at threaded connection 440. It will be seen by those skilled in the art that valve seal 434 is adapted for sealing engagement with seat surface 414 in lower slip support 402 when valve body 430 is moved upwardly.

The lower end of valve body 430 is connected to a valve holder 442 by one or more pins 444. Valve holder 442 is disposed in second bore 422 of valve housing 416. A sealing means, such as O-ring 446 provides sealing engagement between valve holder 442 and valve housing 416.

Above shoulder 424 in valve housing 416, valve body 430 has a radially outwardly extending flange 448 thereon. A biasing means, such as spring 450, is disposed between flange 448 and shoulder 424 for biasing valve body 430 upwardly with respect to valve housing 416.

Valve holder 442 defines a first bore 452 and a smaller second bore 454 therein with an upwardly facing chamfered shoulder 456 extending therebetween. A ball 458 is disposed in valve holder 442 and is adapted for engagement with shoulder 456.

First Bridge Plug Embodiment

Referring now to FIG. 7, a first bridge plug embodiment of the present invention is shown and generally designated by the numeral 500. First bridge plug embodiment 500 comprises the same center mandrel 102 and the external components positioned thereon as does the second packer embodiment 100. Therefore, the reference numerals for these components shown in FIG. 7 are the same as in FIG. 3A.

The lower end of center mandrel 102 in first bridge plug embodiment 500 is connected to a lower slip support 502 at threaded connection 504. An upwardly and inwardly tapered shoulder 506 on lower slip support 502 engages shoulders 140 on lower slips 136 or 136'. As with the other embodiments, slips 136 or 136' are adapted for sliding along shoulder 506.

Lower slip support 502 defines a bore 508 therein which is in communication with mandrel central opening 104 in center mandrel 102.

A bridging plug 510 is disposed in the upper portion of mandrel central opening 104 in center mandrel 102 and is sealingly engaged with internal seal 180. A radially outwardly extending flange 512 prevents bridging plug 510 from moving downwardly through center mandrel 102.

Above bridging plug 510 is tension sleeve 174, previously described for second packer embodiment 100.

Second Bridge Plug Embodiment

Referring now to FIG. 8, a second bridge plug embodiment of the present invention is shown and generally designated by the numeral 600. Second bridge plug embodiment 600 uses the same thin cross-sectional mandrel 202 as does third packer embodiment 200 shown in FIG. 4A. Also, the external components positioned on center mandrel 202 are the same as previously described, so the same reference numerals are used in FIG. 8.

In second bridge plug embodiment 600, the lower end of center mandrel 202 is attached to the same lower slip support 502 as first bridge plug embodiment 500 at threaded connection 602. It will be seen that bore 508 in lower slip support 502 is in communication with mandrel central opening 204 in center mandrel 202.

A bridging plug 604 is positioned in the upper end of mandrel central opening 204 in center mandrel 202. A shoulder 608 in central opening 204 prevents downward movement of bridging plug 604. A sealing means, such as a plurality of O-rings 606, provide sealing engagement between bridging plug 604 and center mandrel 202.

Tension sleeve 238, previously described, is positioned above bridging plug 604.

Setting And Operation Of The Apparatus

Downhole tool apparatus 10 is positioned in well bore 12 and set into engagement therewith in a manner similar to prior art devices made with metallic components. For example, a prior art apparatus and setting thereof is disclosed in the above-referenced U.S. Pat. No. 4,151,875 to Sullaway. This patent is incorporated herein by reference.

For first packer embodiment 20, the setting tool pulls upwardly on tension sleeve 62, and thereby on mandrel 22, while holding lock ring housing 24. The lock ring housing is thus moved relatively downwardly along mandrel 22 which forces upper slips 28 outwardly and shears screws 36, pushing upper slip wedge 32 downwardly against packer elements 40 and 42. Screws 50 are also sheared and lower slip wedge 46 is pushed downwardly toward lower slip support 58 to force lower slips 54 outwardly. Eventually, upper slips 28 and lower slips 54 are placed in gripping engagement with well bore 12 and packer elements 40 and 42 are in sealing engagement with the well bore. The action of upper slips 28 and 54 prevent packer 20 from being unset. As will be seen by those skilled in the art, pressure below packer 20 cannot force the packer out of well bore 12, but instead, causes it to be even more tightly engaged.

Eventually, in the setting operation, tension sleeve 62 is sheared, so the setting tool may be removed from the well bore.

The setting of second packer embodiment 100, third packer embodiment 200, fourth packer embodiment 300, fifth packer embodiment 400, first bridge plug embodiment 500 and second bridge plug embodiment 600 is similar to that for first packer embodiment 20. The setting tool is attached to either tension sleeve 174 or 238. During setting, the setting tool pushes downwardly on upper slip support 110, thereby shearing shear pin 112. Upper slips 116 or 116' are moved downwardly with respect to upper slip wedge 126. Tapers 120 in upper slips 116 or 116' slide along upper slip wedge 126, and shoulders 118 on upper slips 116 or 116' slide along shoulder 114 on upper slip support 110. Thus, upper slips 116 or 116' are forced radially outwardly with respect to center mandrel 102 or 202.

As this outward force is applied to slips 116 in the embodiment of FIGS. 9–11, retaining band 117 is broken, and slips 116 are freed to move radially outwardly such that edges 124 of inserts 122 grippingly well bore 12.

As the outward force is applied to alternate embodiment slips 116' (FIGS. 12–14), ring portion 121 will fracture, probably starting at the base of each gap 123. A typical fracture line 125 is shown in FIGS. 12 and 13. In other words, slips 116' separate and are freed to move radially outwardly such that edges 124 of inserts 122 grippingly engage well bore 12.

Also during the setting operation, upper slip wedge 126 is forced downwardly, shearing shear pin 128. This in turn causes packer elements 40 and 42 to be squeezed outwardly into sealing engagement with the well bore.

The lifting on center mandrel 102 or 202 causes the lower slip support (valve housing 144 in first packer embodiment 100, valve housing 206 in second packer embodiment 200, valve housing 302 in fourth packer embodiment 300, lower slip support 402 in fifth packer embodiment 400, and lower slip support 502 in first bridge plug embodiment 500 and second bridge plug embodiment 600) to be moved up and lower slips 136 or 136' to be moved upwardly with respect to lower slip wedge 130. Tapers 134 in lower slips 136 or 136' slide along lower slip wedge 130, and shoulders 140 on lower slips 136 or 136' slide along the corresponding shoulder 142, 210, 306, 406, or 506. Thus, lower slips 136 or 136' are forced radially outwardly with respect to center mandrel 102 or 202.

As this force is applied to slips 136 in the embodiment of FIGS. 9–11, retaining band 117 is broken, and slips 136 are freed to move radially outwardly such that edges 124 of inserts 138 grippingly engage well bore 12.

As the outward force is applied to alternate embodiment slips 136' (FIGS. 12–14), ring portion 137 will fracture, probably starting at the base of each gap 139. A typical fracture line 125 is shown in FIGS. 12 and 13. In other words, slips 136' separate and are freed to move radially outwardly such that edges 124 of inserts 138 grippingly engage well bore 12.

Also during the setting operation, lower slip wedge 130 is forced upwardly, shearing shear pin 132, to provide additional squeezing force on packer elements 40 and 42.

The engagement of inserts 122 in upper slips 116 or 116' and inserts 138 in lower slips 136 or 136' with well bore 12 prevent packers 100, 200, 300, 400 and bridge plugs 500, 600 from coming unset.

Once any of packers 20, 100, 200, 300, 400 are set, the valves therein may be actuated in a manner known in the art. Sliding valve 164 in second packer embodiment 126, and sliding valve 22 in third packer embodiment 200 are set in a similar, if not identical manner. Sliding valve 318 in fourth packer embodiment 300 is also set in a similar manner, but does not utilize collets, nor is alignment of sliding valve 318 with respect to ports 316 in valve housing 302 important. Sliding valve 318 is simply moved below ports 316 to open the valve. Bumper seal 314 cushions the downward movement of sliding valve 318, thereby minimizing the possibility of damage to sliding valve 318 or valve housing 302 during an opening operation.

In fifth packer embodiment 400, the valve assembly comprising valve body 432, valve seal 434, valve spacer 436, valve head 438 and valve holder 442 is operated in a manner substantially identical to that of the Halliburton EZ Drill® squeeze packer of the prior art.

Drilling Out The Packer Apparatus

Drilling out any embodiment of downhole tool 10 may be carried out by using a standard drill bit at the end of tubing string 16. Cable tool drilling may also be used. With a standard "tri-cone" drill bit, the drilling operation is similar to that of the prior art except that variations in rotary speed and bit weight are not critical because the non-metallic materials are considerably softer than prior art cast iron, thus making tool 10 much easier to drill out. This greatly simplifies the drilling operation and reduces the cost and time thereof.

In addition to standard tri-cone drill bits, and particularly if tool 10 is constructed utilizing engineering grade plastics for the mandrel as well as for slip wedges, slips, slip supports and housings, alternate types of drill bits may be used which would be impossible for tools constructed substantially of cast iron. For example, polycrystalline diamond compact (PDC) bits may be used. Drill bit 14 in FIG. 1 is illustrated as a PDC bit. Such drill bits have the advantage of having no moving parts which can jam up. Also, if the well bore itself was drilled with a PDC bit, it is not necessary to replace it with another or different type bit in order to drill out tool 10.

While specific squeeze packer and bridge plug configurations of packing apparatus 10 has been described herein, it will be understood by those skilled in the art that other tools may also be constructed utilizing components selected of non-metallic materials, such as engineering grade plastics.

Additionally, components of the various packer embodiments may be interchanged. For example, thick cross-sectional center mandrel 102 may be used with valve housing 206 in second packer embodiment 200 or valve housing 302 in fourth packer embodiment 300. Similarly, thin cross-sectional center mandrel 202 could be used with valve body 144 in second packer embodiment 100 or lower slip support 402 and valve housing 416 in fifth packer embodiment 400. The intent of the invention is to provide devices of flexible design in which a variety of configurations may be used.

It will be seen, therefore, that the downhole tool packer apparatus and methods of drilling thereof of the present invention are well adapted to carry out the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments of the apparatus and various drilling methods have been discussed for the purposes of this disclosure, numerous

changes in the arrangement and construction of parts and the steps of the methods may be made by those skilled in the art. In particular, the invention is not intended to be limited to squeeze packers or bridge plugs. All such changes are encompassed within the scope and spirit of the appended claims.

What is claimed is:

1. A downhole apparatus for use in a well bore, said apparatus comprising:
   - a center mandrel; and
   - slip means disposed on said mandrel for grippingly engaging said well bore when in a set position, said slip means being at least partially made of a non-metallic material.

2. The apparatus of claim 1 characterized as a packing apparatus and further comprising packing means disposed on said mandrel for sealingly engaging said well bore when in a set position.

3. The apparatus of claim 2 wherein said slip means is an upper slip means disposed above said packing means and further comprising a lower slip means disposed below said packing means, said lower slip means being at least partially made of a non-metallic material.

4. The apparatus of claim 1 wherein said slip means comprises a slip support made of a non-metallic material.

5. The apparatus of claim 1 wherein said slip means comprises a slip wedge made of non-metallic material.

6. The apparatus of claim i wherein said slip means comprises:
   - a plurality of non-metallic slips disposed in an initial position around said mandrel; and
   - retaining means for holding said slips in said initial position.

7. The apparatus of claim 6 wherein said retaining means is characterized by a retaining band extending at least partially around said slips.

8. The apparatus of claim 6 wherein said retaining means comprises a non-metallic ring portion integrally formed with said slips and being fracturable during a setting operation, whereby said slips are separated.

9. The apparatus of claim 8 wherein said slips define a plurality of gaps therebetween adjacent to an end of said slips.

10. The apparatus of claim 6 further comprising a plurality of hardened inserts molded into said slips

11. The apparatus of claim 10 wherein said inserts are steel.

12. The apparatus of claim 10 wherein said inserts are made of a non-metallic material.

13. The apparatus of claim 12 wherein said inserts are made of a ceramic material.

14. The apparatus of claim 1 wherein said non-metallic material is an engineering grade plastic.

15. The apparatus of claim 14 wherein said plastic is nylon.

16. The apparatus of claim 14 wherein said plastic is a phenolic material.

17. The apparatus of claim 16 wherein said phenolic material is one of Fiberite FM4056J, Fiberite FM4005 and Resinoid 1360.

18. The apparatus of claim 14 wherein said plastic is an epoxy resin.

19. A downhole apparatus for use in a well bore, said apparatus comprising:
   - a center mandrel;
   - a slip wedge disposed around said mandrel;
   - a plurality of separate non-metallic slips disposed around said mandrel adjacent to said wedge; and
   - retaining means for retaining said slips in an initial position out of engagement with the well bore.

20. The apparatus of claim 19 wherein said wedge is made of a non-metallic material.

21. The apparatus of claim 19 wherein said slips are made of engineering grade plastic.

22. The apparatus of claim 21 wherein said plastic is nylon.

23. The apparatus of claim 21 wherein said plastic is a phenolic material.

24. The apparatus of claim 21 wherein said phenolic material is Fiberite FM4056J.

25. The apparatus of claim 21 wherein said plastic is an epoxy resin.

26. The apparatus of claim 19 further comprising a plurality of inserts molded into said slips for grippingly engaging the well bore when in a set position.

27. The apparatus of claim 26 wherein said inserts are hardened steel.

28. The apparatus of claim 26 wherein said inserts are made of a non-metallic material.

29. The apparatus of claim 28 wherein said inserts are made of a ceramic material.

30. A downhole apparatus for use in a well bore, said apparatus comprising:
   - a center mandrel;
   - a slip wedge disposed around said mandrel;
   - a plurality of non-metallic slips disposed around said mandrel adjacent to said wedge; and
   - a non-metallic ring integrally formed at an end of each of said slips and adapted for holding said slips in an initial position out of engagement with the well bore.

31. The apparatus of claim 30 wherein said wedge is made of a non-metallic material.

32. The apparatus of claim 31 wherein said slips define a plurality of longitudinally extending gaps therebetween adjacent to an opposite end of said slips from said ring.

33. The apparatus of claim 30 wherein said ring is made of a fracturable engineering grade plastic.

34. The apparatus of claim 33 wherein said plastic is nylon.

35. The apparatus of claim 33 wherein said plastic is a phenolic material.

36. The apparatus of claim 33 wherein said phenolic material is Fiberite FM4056J.

37. The apparatus of claim 33 wherein said plastic is an epoxy resin.

38. The apparatus of claim 30 further comprising a plurality of inserts molded into said slips for grippingly engaging the well bore when in a set position.

39. The apparatus of claim 38 wherein said inserts are hardened steel.

40. The apparatus of claim 38 wherein said inserts are made of a non-metallic material.

41. The apparatus of claim 38 wherein said inserts are made of a ceramic material.

* * * * *

90007107.070604

CERTIFICATE OF COMPLIANCE

I certify that the foregoing BRIEF FOR APPELLANT HALLIBURTON ENERGY SERVICES, INC. contains 13,966 words as measured by the word processing software used to prepare this brief.

Dated: December 15, 2003

Respectfully submitted,

Darrel C. Karl
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Attorney for Appellant
Halliburton Energy Services, Inc.

90007107.070604

CERTIFICATE OF SERVICE

I hereby certify that two copies of the foregoing BRIEF FOR APPELLANT HALLIBURTON ENERGY SERVICES, INC. were served this 15th day of December, 2003, upon counsel of record listed below by overnight Federal Express:

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Kay Wylie

Exhibit

NOTE: Pursuant to Fed. Cir. R. 47.6, this disposition is not citable as precedent. It is a public record.

United States Court of Appeals for the Federal Circuit

04-1018

HALLIBURTON ENERGY SERVICES, INC.,

Plaintiff-Appellant,

v.

WEATHERFORD INTERNATIONAL, INC.,

Defendant-Appellee,

and

BJ SERVICES COMPANY,

Defendant-Appellee.

Judgment

ON APPEAL from the UNITED STATES DISTRICT COURT NORTHERN DISTRICT OF TEXAS

in CASE NO(S). 02-CV-01347

This CAUSE having been heard and considered, it is

ORDERED and ADJUDGED:

Per Curiam (CLEVENGER, RADER, and SCHALL, Circuit Judges).

AFFIRMED. See Fed. Cir. R. 36.

ENTERED BY ORDER OF THE COURT

DATED JUN 14 2004

Jan Horbaly, Clerk

Exhibit

****

SWORN STATEMENT

OF

MONTY EARLE HARRIS

MARCH 12, 2002

****

SWORN STATEMENT OF MONTY EARLE HARRIS taken on the 12th day of March, 2002, before Kathy K. Elliott, Certified Court Reporter in and for the State of Texas, at the offices of Simon, Warner & Doby, L.L.P., 1700 City Center Tower II, 301 Commerce Street, Fort Worth, Texas.

APPEARANCES

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INDEX OF EXHIBITS

EXHIBIT NUMBER		PAGE NUMBER
A	Composite Catalog of Oil Field Equipment & Services	27

MONTY EARLE HARRIS,

having been first duly sworn, testified as follows:

EXAMINATION

BY MR. BOOTH:

Q. Mr. Harris, you understand you are under oath and I want you to do your best to tell us your recollection of the facts or your experiences, and I want to go back to your first job, I believe was with Baker Oil Tool; is that correct?

A. That's correct.

Q. Before we get into that let me ask you a couple of personal things. You have an associate engineering degree in mechanical engineering?

A. That's correct, two years.

Q. Okay. And you've been a practicing associate engineer all of these years?

A. Yes. Every title that I've ever had was associate working under a PE engineer.

Q. And I think you've probably been in the oil patch your whole career as best I can tell; is that correct?

A. That's correct.

Q. And your first job was about 19, what, '80? No excuse me, '70. '60?

A. '60.

Q. With Baker Oil Tool; is that correct?

A. Yes, sir. I went to college and worked for them previous, you know, and then went to work full-time for them after that.

Q. What was the time frame that you worked at Baker?

A. Full-time?

Q. Just start to finish.

A. '60 to -- I worked 11 years so '71, I think. Let's see, I mean -- I would have to look at what -- '73. '63 to '73.

Q. So during the period you were at Baker Oil Tool, where were you physically?

A. I was in their southern region working mainly out of Corpus Christi, Texas.

Q. Okay. And what were you doing for them?

A. Well, when I went to work for Baker they had programs that you could get into, career programs, so I went into their engineering program, so there was three steps that you went through with Baker. The first one you did warehouse work for six months, working on their service equipment. So the second job I had was actually for one year servicing and running the tools in the oil field. And the third job I had was regional engineer that I made the trouble jobs and helped set up

completions, and just regular engineering work.
Q. What kind of tools in particular at Baker are you talking about?
A. Production and service tools.
Q. These are downhole well tools?
A. Downhole well tools, that is correct.
Q. When you were the regional engineer, you went out on problem jobs and helped install new tools and ran test programs and that sort of thing; is that correct?
A. Yes, when it was in our region, I did that.
Q. Baker had some -- and I can't right now recall, but they had some reports that they would require to be filled out when a new tool was run.
Do you remember the name of those reports or --
A. No, sir, I can't remember the name of them, but there certainly was a system.
Q. A report that was filled out when a new tool was run, or when a problem tool was run there was a system of reports like that?
A. Yes, there was a system but it was -- there was a lot of times that if we modified an existing line and changed components on it, it didn't fall under those programs.
Q. What do you mean?

A. Okay. In my region if they sent a research tool, a prototype, that was a new tool to the company, it had a system like you're talking about that went with it, misruns, new runs, that's a tracking method for the equipment. Now, if we had a product in our districts that we had been selling before and the request came in for a modification on that, it did not follow those systems.

Q. Okay. And what would happen if you were out installing a tool, or not you but Baker, and they had a problem of some sort in the installation of the well?

A. You're talking about a new tool or an existing?

Q. Just anything you're running.

A. Well, in the early part of the '60s, one of our jobs -- my job was to, let's call it, squelch the problem at the field level before it got in to the lawyers.

Q. Okay.

A. In other words, it's very obvious there is times that we had new tools that failed that cost rig time and other things like that. Now, my job and the district manager's job would be to go to Marathon, or whoever we were working for, and make compensation normally in future work. So I hope that answered your

question.

Q. Well, it seems like I had read that Baker had a reporting system that when they had a tool stuck, break or failure of some sort, whether it was theirs or whatever at the site, the field engineer or whoever was supervising the work would prepare a report and then it would be sent back to whoever.

A. That was on new tools prototypes, yes.

Q. But not on the old existing tools?

A. No. My recollection is there wasn't any formal reporting system on existing equipment.

Q. You described to me previously, or mentioned to me previously that you had been working on some water flood or either saltwater disposal tools for Baker. Do you recall that?

A. Yes, sir.

Q. Why don't you tell me what that was. I mean, I'm just trying to get you to --

A. I had a --

Q. Let's talk about the metallic tools first.

A. I had a real good customer, Marathon Oil Company, in Sinton, Texas, and they were producing wells that had only about 7 percent oil and the rest was saltwater. Now, they had systems that they -- was economically feasible to get rid of the saltwater and

still make money. Now, to do this they had to use some type of packer downhole that would assure that the saltwater was going into the formation that it was supposed to and not into our freshwater systems if they had a hole in the pipes.

Q. Let me stop you a minute because I think you skipped over some facts here.

A. Okay.

Q. To get rid of the saltwater that was separated from the produced oil, they would separate the saltwater, correct?

A. Yes.

Q. And then they would take it and pump it back into the ground in another well or another formation?

A. That's correct.

Q. Okay. And that's what you're talking about pumping it back, right?

A. Yes. That's correct.

Q. All right. Go ahead then.

A. Well, like any saltwater that you produce with a hydrocarbon, its erosion characteristic -- I mean, what eats the pipe up. I can't think of the word.

Q. Corrosion.

A. Corrosion. Okay. -- is tremendous. And what was happening in this area was the wells that they were

using for disposal were constantly being worked over because of the pipe and the packer itself corroding out. So Marathon started running Fiberglas pipe to stop this problem with their tubulars in the well.

Q. Was this in a metallic casing?

A. Oh, yeah.

Q. Okay.

A. It was in a metallic casing. Well, with that change from their metallic tubing to Fiberglas, I also made sales calls.

Q. The tubing was working, though?

A. The Fiberglas tubing? To a certain extent.

Q. Keeping the corrosion now --

A. Oh, yeah, as far as corrosion it was excellent.

Q. What do you mean, "to a certain extent"?

A. Well, it's not really good in tension and compression and torque and things like that.

Q. Before you get into the next step, the packers that were being used for this were retrievable packers?

A. The initial tools that we had in this Whitepoint area and Sinton area were -- even the ones we ran on Fiberglas at first were tension-type retrievables.

Q. I believe you told me they were the RA type?

A. AD.

Q. AD type. Excuse me. I went back to the catalogs at one point. Is this what you're talking about?

A. That's correct.

Q. The Baker AD tool from the 1970/'71 composite catalog?

A. Yes.

Q. Okay. All right. So those were tension packers, and what was going wrong with them?

A. Well, the mandrel in the inside diameter was also corroding out on it. I mean, they spent all of this money and time researching and running Fiberglas tubing, but we still had a steel mandrel and the lower components on the AD tension packer.

Q. Was there tubing on the bottom of this AD --

A. No, sir.

Q. Okay.

A. It was blank or just like you're seeing in the picture.

Q. Okay. So you were still getting corrosion on the metal packer on the Fiberglas pipe?

A. That's correct.

Q. Okay. And this was from Marathon?

A. That's correct.

Q. And so these would corrode and you would basically have to rebuild the packer when you took them out to service the rubber, or sell them a new packer?

A. Well, what would happen is above this element system, if you corrode a hole in it, you've got communications into that casing you asked me about, and the Railroad Commission will make you shut the well down. They are afraid that the fluid that's leaking here comes up the casing; if you've got a hole in freshwater that people drink, saltwater would go out and ruin their water. So it was -- we were having these corrosion problems because we didn't change anything. Now, we tried coating them internally and that didn't work.

Q. So if a hole or a passageway corroded in either the pipe before you went to Fiberglas, or in the mandrel part, or the connection, then you would have failure back to the annulus and the Railroad Commission would shut you down, and that's one of the failures you were seeing with the metallics?

A. That's correct.

Q. Okay. And what would happen to all of this slip area up in here when you had the corrosion problems, would it lock up?

A. Well, to understand it just a little bit,

anything below the rubber is what we call water wet, it sees saltwater.

Q. Yes.

A. Anything above it in the annulus, we would normally just put freshwater. So only the inside of the mandrel and the bottom components would see the saltwater on the steel or any of them.

Q. Okay. The AD packer -- tension packer was a packer that -- and I'm reading here from the brochure -- but you screwed it into a length of tubing, lowered it into the well, and it had a drag on it or something that contacted the casing, and then you would lift and turn and then pull up, and it would load up the packer and you would have to keep supporting it from the wellhead for it to work?

A. That's correct.

Q. And when you wanted to take it out, you would lower it back down and turn it the other direction, and then theoretically would bring everything back up when you wanted to service it?

A. That's correct.

Q. Or retrieve it? All right. Go on. So you were having problems with these packers?

A. Yes, sir.

Q. And what is the next thing you did?

A. The field foremen, the guys that normally control these purchases of items --

Q. The what?

A. Normally back then, like Marathon Oil Company, they had field foremen that looked after fields.

Q. All right.

A. So these guys were responsible for these particular areas. Bob Semp, a good friend of mine who ran one of the fields, one day said, Monty, why in the world can't y'all build an AD-1, we called it -- an AD-type tool we're using with a Fiberglas mandrel. We've got tubing, why in the world can't we do that.

So I contacted engineering at the time -- that was part of my job, bringing requests from customers in -- and eventually it ended up with an AD packer that had not only a Fiberglas mandrel in it, but this lower cone shear ring was brass, which can affect it, and that bottom connection was all Fiberglas because it was water wet, we call it.

And the best I can remember, I personally ran three of them because one of the suspected problems that we would be having with those is to set this tool like you described by rotation, we actually had to mill down in the Fiberglas to a real weak place, and I was real scared about pulling on it, so I wanted to be the first

one to go run it.

The second thing was that shear ring, the emergency release in this tool, even though it was brass, it also set in a groove that was cut into that Fiberglas mandrel. So the first thing I ran we had success with, then it just went into the district normal tool category and I don't recall how many was ran.

Q. All right. Now, this part Fiberglas Baker packer, it had a shear ring in it so that you could get emergency release procedure like is described here in the composite?

A. That's correct.

Q. Okay. And you would pull up on it and the shear ring would pop and then you would get it out of the hole if it got stuck?

A. Yeah. The ring, when it sheared, would de-energize everything and separate the cone from the slip.

Q. Tell me the best you can the time, or year, date, that you and Bob Semp had this first conversation.

A. This is probably going to be a guess. I had gone through the programs needed to put me as the regional engineer, so that's going to be three years. '64, '65, somewhere in there.

Q. All right. So you called -- and I believe you

told me on the phone when we were discussing this -- you called engineering and suggested that they use some Fiberglas on the internal parts and they said, no, no, we're going to use something else?

A. Yes.

Q. What was that?

A. Well, they insisted they could coat it with a plasticoating because they were very concerned about the same things I was when I ran them.

Q. Which was?

A. Well, that we had to mill slots and it got weak and -- for the shear ring and for the J-mechanism at the top. So they, with correspondence, and me working with Marathon, was trying to convince us to do an internal coating, and it's called -- it's a plastic coating where you -- TK69 or something like that.

Q. So the saltwater wouldn't reach the metal?

A. Wouldn't reach the metal.

Q. I think you told me also they wanted to use some exotic noncorrosive metal to --

A. Yeah. They wanted to use some CRA, which is corrosion-resistent alloy. And back then it was hastiloid. And that mandrel would have cost about $600, and the whole packer didn't cost but 250. So economics and Bob Semp, plus he wanted Fiberglas, that's the

direction it went.

Q. Is Bob still around?

A. No. He's dead.

Q. Okay. So this would be 64, '65ish; is that fair?

A. Again, I mean, I'm just -- I'm trying to put the years the best I can. Yes.

Q. Sometime in the '60s?

A. Yeah, early '60s.

Q. All right. In your declaration you said you ran two of these, just a minute ago you said three. Do you remember which one it was?

A. Well, the third one was a combination tool.

Q. Okay. Let's start with the first two then.

A. Okay. The first two just had like I said, and the third one, we started trying to go to all composite Fiberglas.

Q. Okay. So the first step or the first -- the first two that you ran, it says here you ran them at Marathon?

A. Yes, sir.

Q. Okay. And you were personally there when those were installed?

A. Yeah. I ran them.

Q. Okay.

A. Now, I remember -- do remember, though --

Q. By running them you mean you were there at the well site and watched them grease these things up and run them down the hole and attach them and pull up on them and get them in position?

A. That's correct.

Q. All right. And that was for Marathon?

A. Yes, sir.

Q. And that was the first test run that was ever run of these as far as you know?

A. Yeah.

Q. And did you fill out test reports as you would on a new tool? You did?

A. Yes.

Q. Okay. And do you have any records or any documents, or know where any records or documents are that we can get our hands on of this 1960s time frame that would show the structure or anything else of these either all Fiberglas or the two tools you ran for Marathon?

A. No, sir, I don't know where you would get them.

Q. Okay. And let's stay with the part steel or part metal, part Fiberglas one. You're personally aware of only two of those ever being run?

A. Yes, sir.

Q. Okay. And in your declaration you said that I recall that several of these packers were also sold to Mobil Oil Company. And I believe you told me on the phone somebody had told you that, that they had been sold to Mobil?

A. Yes.

Q. But you don't know -- you didn't personally observe it?

A. Absolutely not. They were in West Texas, which wasn't even my region.

Q. But Marathon was your customer, right?

A. Yes.

Q. Okay. Now, let's go on to this -- and do you have any other personal knowledge, other than these two part metal/part Fiberglas tension packers that were run in the '60s -- do you have any knowledge of that design being run anywhere else?

A. Personal knowledge? In other words, was I on location, is that what you mean?

Q. Yes. You personally saw.

A. No, I personally didn't.

Q. You personally didn't see any more than those two tools?

A. Oh, yeah. As far as look at them with my eye?

Q. Yes.
A. I ran the first prototypes and turned it over to the district, so any application after that the tool men ran. So every time I would go to the shop there would be crates laying with these things.
Q. So there were a bunch of these part metal/part brass they were running?
A. Yeah. I mean, I assume they were running. They were in the district. I didn't -- other than talking to Bob, how they are doing.
Q. You were talking to Bob Semp at Marathon?
A. Yeah.
Q. Okay. And so you believed then based on seeing some other packers at the district that some others may have been run?
A. Yes, sir.
Q. What problems did you have with the first two?
A. Well, the first two -- the first one I ran, suspecting the weak points in the tool, this was a rather shallow well and like I said, Bob was a good friend of mine, he was pushing for these -- I mean, it's his idea so this guy was really --
Q. He was behind it?
A. He was really behind this project. So I asked Bob, I said, look, can we do something, because this is

a shallow well, that will help both of us. He said, Yeah. He said, What is it? I said, Let's run it to -- so many stands. It was very little depth in the well. Let me set it and shear -- the shear ring, because that was the weak part in the mandrel, and let me retrieve this and let's see what that mandrel looks like. He said, well, what are we going to do if it's messed up? And I said, Well, I have another packer at the shop. So he said okay.

So we ran it in and I pulled on it and sheared it, and it came out all right, but the groove in that Fiberglas, it was cut with a machine, or that brass set in there, it rolled the Fiberglas down rather than sheared the ring good.

Now, that was not a failure. It was just testing a part that was really suspect in the design. So obviously I went and got the other packer and then we redressed that one.

Q. You put another Fiberglas --

A. Yeah. Between this one. We had two.

Q. I see. That's why you had two. So you ran it -- ran it down, and as a test you pulled on it to see if it could do this emergency release procedure so you could still get it out of the well if it got stuck?

A. That's correct.

Q. And you went back and got another packer and reset it for this one well?

A. We didn't go through the release.

Q. So this was one well instead of two wells but you ran two packers?

A. No. When we redressed that other one, I ran it in a mating well to this.

Q. What did you do with the well that you run this one in?

A. We just ran it as a packer, started disposing saltwater.

Q. I misunderstood. You had two of these part composite/part metal packers, correct?

A. That's correct.

Q. And you took one out and you set it and did the emergency release, in which you case you broke the Fiberglas around the release ring, and you disposed of that or sent it back to the shop or --

A. Well, what I did, I mean is, I should have brought the other one with me, I didn't. Of course it was about a 30-mile trip, so I ran in and picked up the other one, and left the other one in the shop that we had screwed the mandrel up, messed it up. Now, I go out for Bob and I run it to bottom, where we're going to set it, I pulled on it, and now they start disposing of

saltwater.

Q. Okay.

A. Now, the shop people replaced that mandrel that I -- so what we learned was that every time we shear this, we're probably going to mess the mandrel up.

Q. Okay.

A. And it was an acceptable, quote, cost, and whatever the emergency release is because it was very cheap metal.

Q. All right. So it had metal slips, metal slip cone, rubber element, Fiberglas mandrel and brass ring below the -- I guess the extrusion ring below the seal?

A. Shear ring.

Q. And a brass shear ring. Okay. And now, there's a third packer during the Baker period you mentioned that you said you went to an all Fiberglas packer?

A. Correct.

Q. Okay. Who did that or how did that come about?

A. Well, again, after the prototypes of these were run, Marathon again wanted to carry this a little further. I was totally against it, but whatever, they're the customer. Let me refresh my memory here.

The best I can remember, it obviously had an all Fiberglas mandrel, and the water weighted parts were Fiberglas, the top cone was Fiberglas, but I think the slips were steel, and I know the top collar was Fiberglas.

Q. So it was steel -- part Fiberglas, part steel, but it had some more Fiberglas parts on it?

A. Yes.

Q. Okay. There's a Baker advertisement from June '68 that was given to me. Do you know where that came from?

A. There was an earlier one than that that had that packer in there. Let me look at that.

Q. I think this one has it in there.

A. Okay.

Q. In the one on the left the AD packer?

A. I guess so. Mine didn't look like this, I'll tell you that. I guess what I'm trying to say is -- there another picture in here?

Q. That's the only one.

A. World Oil, right after I ran these tools, had one with that packer right there, the initial ones, and it set up in the corner, the actual tool picture, and it told what we were doing and where we were headed and the reason why. It was before that advertisement.

Q. There was another ad that you --
A. Oh, yeah. In fact, I was real surprised, Baker don't usually move that fast with their advertising, that it came out as quick as it did.
Q. So we found that out we would know the date?
A. Yeah, that the advertisement came out.
Q. Sure. This June of '68 advertisement here --
A. That's an evolution from our first one.
Q. So this would be later than --
A. Oh, yeah.
Q. The one on the left is, I guess, the all metal tension packer that's an AD packer?
A. No, both of those are all Fiberglas.
Q. Well, it says that --
A. Well, you know, if you read it, it says the reason they are corrosion proof, they are Fiberglas. Now, as far as components, I would be -- I could look and see an opinion of what's metal and what's not, but I know they didn't drop this project because it -- they evolved it because it was making them money. If you dig further back in World Oil, you'll find it.
Q. I didn't find this. This was given to me by somebody.
A. Okay.
Q. This advertisement says you got -- they have

an all Fiberglas construction, and they have one that's cannigan-plated metal setting mechanisms, which would be metal slips, I guess, and cones. So this one, as I read it, was showing a metal, a part metal, and an all Fiberglas. Is that your understanding?

A. Yeah.

Q. And the one on the left is the one that has the metal slips?

A. Right.

Q. And the slip cone, right?

A. Certainly looks like it.

Q. Okay. You don't recall this June advertisement other than having seen it recently?

A. That's the first time I've really seen that.

Q. Okay. And then at some point the all Fiberglas one was also tested? That's right, you said you don't recall that it was part metal/part Fiberglas.

A. I don't recall.

Q. Okay. You left Baker -- let me ask you this: Other than this World Oil ad, are you aware of any other documents or -- maybe a second World Oil ad, but any other documents that relate to these part composite or part Fiberglas tension packers?

A. No, sir. I can tell you -- I'm trying to think. Baker advertised in World Oil and they

advertised in -- I can't think of the other magazine so I can't -- I'll just say no.

Q. You left Baker in '73 then?

A. Yeah.

Q. And went to work for Dowell?

MR. STEVENS: Excuse me, John, if we are finished with that, may we mark a copy of that Baker catalog part just so it's clear what we were referring to, please?

MR. BOOTH: I'll give you one.

MR. STEVENS: That's fine. I would just as soon have it attached to the transcript so it's clear what you both talking about.

MR. BOOTH: Mark the composite as Harris Attachment A.

MR. STEVENS: Thank you.

(Marked Exhibit A)

Q. (By Mr. Booth) You left Baker in about 1973; is that correct?

A. That's correct.

Q. And then worked for Dowell from '73 to '80?

A. That's correct.

Q. And during the time you were with Dowell you didn't work with any nonmetallic packers, bridge plugs, or downhole tools?

A. No, sir.

Q. That's correct, you did not?

A. That's correct, I did not.

Q. Okay. All right. Then the next period of your employment was you went to work from -- well, it says '80, Incorporated Harris Tool.

From '80 to '83 you worked for the Western Company of North America?

A. Yes, sir.

Q. And what was your position at the Western Company?

A. My first position was senior project engineer.

Q. What was that?

A. What were the responsibilities?

Q. Yes.

A. Well, in our engineering department, it's just like most of them, is you have associate engineers, junior engineers, and then you have a senior project engineer that has a group, and they hand you projects, and you are the manager of those projects, and you also work on them as an engineer. So my group, we had a pool of drafting people, so my engineers would pool the drafting people to do the drawings and things. And I was the senior project engineer.

Q. I didn't make my question clear. I believe

you told me when you first started with Western you were like a field engineer again?

A. No, sir.

Q. And is that not correct?

A. No, sir, that's not correct.

Q. Okay.

A. I was hired in as a senior project engineer.

Q. Maybe it's the nomenclature that has me confused. And this was to go out and do jobs, not design stuff?

A. No. This -- I guess, let me try to clarify this.

Q. Sure.

A. Okay. When I was hired in, my title was senior project engineer. It has nothing to do with the field itself.

Q. Okay.

A. Within six months they made me field engineering manager. Now, at that time, yes, I had a group of engineers and we handled the field engineering problems.

Q. Okay. At that time?

A. At that time.

Q. All right. And when you first started with Western, what was their business, oil field business?

A. They were a service company that had offshore drilling rigs, they had pump trucks, cementing and acidizing equipment, and they were going to start in the tool business. That's one of the reasons that I was hired in.

Q. Okay. And I believe you said that Western had an office building and a couple of yards and a test well at that time?

A. Well, the Fort Worth facility, yes. I mean, they were -- I guess I'm confused. Ask that again.

Q. Well, I was just trying to just get an overview of what Western was doing when you started with them.

A. Okay.

Q. But they had an office building with a bunch of boys here in Fort Worth?

A. Yeah, they had several buildings, you know. They had a huge research center out north of Shell Creek.

Q. Shell Creek.

A. Yeah.

Q. Okay. You had a test well somewhere?

A. Out there, yes, sir.

Q. And that was all fenced in and secured?

A. That's true.

Q. And where was the engineering group that you were talking about?

A. We were in the Western Towers that are located on I-30. Two twin towers.

Q. And I believe you told me that was a secure building with guards, as normal business offices are?

A. Yeah. I guess so. We were interchanging -- well, let's put it this way: General Dynamics had some of their groups in there so security was -- for them was real tight. Yes, nobody could come to our floor without being announced.

Q. So the first thing you did, or one of the first things you did, was begin to work on proprietary tools for Western?

A. Yes, sir. What they did, they made me field engineering manager and assigned the engineers and we defined what our responsibilities were. Now, the engineering department, they had no one with field experience or engineering experience for tools so they said, Mr. Harris, you're also going to be responsible for the new tool engineering group.

Q. And that was based on your experience at Dowell?

A. Yeah.

Q. And Baker?

A. Well, my whole career.

Q. Okay.

A. Yeah.

Q. Okay. Was Western running and installing cement plugs and packers and bridge plugs as part of the services they were providing to their customers?

A. You mean when I took over the tools?

Q. When you started with them. Were they buying tools and installing them?

A. I think they -- I'm just going to have to say I think. I think they had a district in West Texas and one in Louisiana that purchased certain type tools that complemented their cement business.

Q. For example.

A. Cement retainers, permanent bridge plugs. That was probably the two major ones.

Q. Okay. So what were you told when you were assigned this project or interviewed for this job that they were going to do about new tools?

A. Well, the best I can remember is during the initial phases of me going to work for them, I certainly wanted to know what their ambitions were in the tool business because I had worked with two major ones that that is their business. And this couple of weeks of negotiation to know when they are serious about getting

in the business, I asked them for a budget.

Q. This is when you were interviewing?

A. Yes.

Q. All right.

A. So let's see how serious you are, let's see a budget you're going to give me. Well, obviously they said right now we can only hire you in as a senior project engineer, but when we get our organization ready then you will be given that and here's your budget that you'll get, and they stood up to their word. They also told me how many -- at the time, this was about a year and a half, two-year period, how many engineers I could hire.

MR. STEVENS: John, if I may, I don't think we want to burden this record, but we'll make just a brief notation that Mr. Harris at the end of 1999 suffered a closed-head injury and one of the consequences of that is that he fatigues early when being questioned, such as we're doing now, and I'm going to request that we just take a 10-minute break.

MR. BOOTH: That would be fine.

(Recess held)

Q. (By Mr. Booth) I want to go back to Baker a minute. That's the problem with taking a break is I can think of something else I didn't ask.

What pressures were those saltwater disposal packers?

A. They would get nervous if it was over 1,000 pounds.

Q. You had told me once it was real low pressure stuff?

A. Yes.

Q. Okay. And you mentioned here in your declaration that there were problems with the Fiberglas -- parting of the Fiberglas?

A. Yeah.

Q. What does parting of the Fiberglas meaning?

A. On that AD-1 -- let's see, where is the drawing here. This was a Fiberglas coupling, the same that was on the tubulars, screwed on right there to a thread. And there were several occasions during the production life when the pumps kicked in and out and surged that they parted right there.

Q. That the Fiberglas tubing would break apart?

A. Mandrel -- the Fiberglas mandrel.

Q. Do you have personal knowledge of those -- how do you know that happened, because you told me a while ago you had only run the two?

A. Well, obviously Bob Semp was one of my best golf buddies and everything else, and anything that

happened on that lease, it was mine. I heard about it.

Q. So just so we have it clear where that came from, Bob Semp told you that some of the Fiberglas packers had broken or parted, as you called it?

A. Yeah.

Q. Okay. Do you have any personal knowledge that any of these, either the two that you installed or any of the others that you may have heard about -- you understand what I'm asking -- personal knowledge that any of those were ever drilled out?

A. Well, the only -- let's put the only personal knowledge I had, we had a district manager, one morning I was out at the district in Corpus Christi, and he said how many of these are we going to have to drill up.

Q. Because they were failing?

A. Well, evidently there was a failure.

Q. But I'm asking about your personal knowledge.

A. No, just that one.

Q. And do you have any records or anything about any drilling up of any of these?

A. No, sir.

Q. Okay. And do you have any personal knowledge of any of the all Fiberglas being drilled up?

A. Yes, sir. I was on location on one of the all Fiberglas --

Q. Now, wait a minute, Monty, I'm confused because a while ago you said you didn't have any personal knowledge of the all Fiberglas tool.

A. That's correct.

Q. Okay. So do you have any personal knowledge of it ever being drilled out?

A. Okay. Let's put it this way, the one that was the combination -- there was three, okay? There was two I said was the Fiberglas mandrel in the water-wetted equipment. Then they went a little further with the product and put the collar in the top cone. Okay.

That's the one that we had to go in -- and I think what happened, we got a hole in the casing and sand fell on top of it, and I got a call saying they couldn't retrieve it. So I went to location and the tool man was out there, and best of my recollection, said, Monty, I've done everything I can to release this thing. He said, I think we have something on top of us. And I said -- he said, I wanted you out here before I pull and go with that emergency release. And I said, Okay. So we pulled and we came out with that top sub.

Q. This was to shear the --

A. The emergency release.

Q. So the mandrel broke in half?

A. Well, yeah. Right on the top it broke off.

So we get out of the hole and we did have sand when we went back in, so that meant -- I mean, we had, like, a bunch of feet. I don't know the amount. So I said, Bob, what do you want to do? He said, I want to mill over and push it to the bottom. Let's run a mill. Because he knew sand was below it, too, from his --

Q. You're talking about a side cutting mill?

A. No. Just a wash-over shoe. We ran a shoe. He didn't do anything to the well. We just burned over the packer and pushed it to the bottom.

Q. Okay. Burned over. What I call a side-cut mill is something that looks like an open-ended tin can with a blade on the bottom of it that you reach over a tool and cut the --

A. That's the same thing.

Q. So what he did was he went down there and cut the -- milled out the packer -- excuse me, the slips were engaged on the side or whatever -- sand or whatever?

A. Well, we burned until it dropped so we don't know.

Q. And then the tool fell on out?

A. Well, we pushed it. It didn't just fall.

Q. Pushed it. Okay. But am I understanding that the tool is -- that you use is something like this, that

you go down around the outside and cut?

A. That's correct.

Q. Okay.

A. We call it a burn-over shoe.

Q. Burn-over shoe. Is that industry trade?

A. That's what we call it. Or a milling shoe.

Q. Okay. And you weren't milling a mandrel or any internal parts, you were just cutting the sides loose?

A. Yeah, we were just burning over it.

Q. All right. I think I understand. All right. Let's go back to you, you're starting at Western and you're talking about this AFE, authorized field expenditure?

A. Yes, sir.

Q. And the first thing they told you is they were going to give you an AFE to hire some people to develop some proprietary tools? That was your job?

A. No, sir.

Q. Well, take me through it chronologically.

A. Okay. When they moved me and created a new group called field engineering, they said that you will also be responsible for the new tools that we're going to start into. Okay. Now, they gave me a budget for hiring new engineers. I had some choices of taking some

engineers that were already in other groups. Now, that wasn't an AFE, that was just an internal budget that you have and obviously you'll call it funny money.

Q. But that wasn't the money for -- I mean, the engineers weren't charged against that AFE?

A. No.

Q. Okay.

A. Now, what happened was each -- and I'm going to talk tools because that's what we're here for.

Q. Correct.

A. When we started getting into the tool systems, Western had a real good system set up that you didn't build anything until marketing came in, and sales, with projections.

Q. Okay.

A. They had to -- and they set priorities. Okay. What we would do is we would visit these regions once a year, or maybe twice a year, depending, and we would take their projections and what type tools they wanted, and we would come back and put cost to it, design, and we would put the two together with marketing and see if we could make money on the tool.

Now, once it went through that process of screening, then we would present the, at the time the engineering manager or the region -- excuse me -- the

CEO and request an authorized field expenditure to cover our project that we were going to do.

And that started the actual me assigning man-hours and engineering, drafting time, all the way to production of the prototypes on a budget. And the reason they stuck with AFEs, because we were field engineering, they called it an AFE. Now, districts also had AFEs because they are field people.

Q. Let me direct you to the point in time that there was an AFE given for a metal cement retainer.

A. Okay. Say that again.

Q. Okay. At some point, and I was going to ask you for a day, you were asked or there was an AFE authorized at Western to make a proprietary metal cement retainer for the company, right?

A. That's correct.

Q. Just take me through that historically, if you can.

A. Okay. We had, like I said earlier, two districts that were in the tool business, and they were purchasing cement retainers and plugs from Pingo Corporation here in Fort Worth. And we were having lots of problems with their equipment. And the business was good enough that they requested we build our own because --

Q. "They" being the company people?

A. The field.

Q. Okay.

A. Marketing, sales and the field districts. They said let's set this priority number one and let's replace Pingo within a certain period of time. Go get an AFE.

Q. So you got an authorization or you did a budget on what it would cost to design it?

A. That's true.

Q. And test it. Submitted that. Sales and whoever looked at the upside of it, the profit to be made, and there was an AFE issued?

A. That's correct.

Q. And as I recall, the first tool, the cement retainer, was an all-metal cement retainer?

A. That's correct.

Q. And there was like a million bucks authorized for this research project?

A. No, sir. I think the first one was like a quarter of a million.

Q. Okay. And that was for your expenditures or your field expenditures in the design and testing of this tool. No, you told me there was also a supplemental AFE, and when was that and how did it come

about, on cement retainers?

A. Okay. We built, tested and sent to the field 20 of these all metals. Okay. And during this process the composite came up. In other words, the tool that we designed that took the place of the Pingo tool took a little bit more time to drill out of the well, and the field felt like that was going to be an obstacle in the future so don't go build a hundred of these right now.

Q. More than the Pingo?

A. Oh, yeah.

Q. So the one that you folks built and designed --

A. It functioned properly and without problems, but when they did have to remove it, which it's drillable, it took more time.

Q. Now, you told me you made two versions of this metal tool?

A. That's correct.

Q. The cheap version, which was like Figure 13 of your patent, and the regular version, which was like Figure 1 of your patent, right?

A. I assume that's the correct numbers.

Q. We've got it. This is your patent number, for the record, 4,708,202?

A. That's correct.

Q. And we call it the '202 patent.
A. You said Figure --
Q. You told me you had built a cheap version, like Figure 13, I believe, is the one with one set of slip seals?
A. That's correct.
Q. You built a regular version like Figure 1 out of all metal?
A. Yes, sir.
Q. Okay.
A. That's the original.
Q. Pardon me?
A. That's the one that we had the original AFE for and we put them in the districts.
Q. But that included both the el cheapo and the regular version in that original AFE?
A. Yes.
Q. And you built and you tested 50, 60, 70 of those, and they were a little slower drilling out?
A. That number seems high. I'm going to say 20.
Q. Of each kind or --
A. Yes.
Q. And you tested them there on your facility?
A. No. We didn't have the whereabouts to do the drilling at the test facility so we ran them in

customers' wells and kept track of --

Q. But that was as a test, the time of the test and everything?

A. Oh, yeah, it was after we had pressure-tested it.

Q. And you got reports back?

A. Oh, yeah.

Q. Take me through a cement retainer. You take it down and it's not like a tension packer, you install it by itself and leave it?

A. Yes, sir. It becomes permanent.

Q. And then you dump cement on top of it?

A. No, sir. It has -- if you'll look at Figure 1, it will help you a little bit more.

Q. It has a valve in the bottom?

A. It has a valve in the bottom. Now, this valve, I'm going to describe it, it's like a faucet. If you pick up on the valve, you close the faucet. You set down on the valve with, we call it a stinger, you open the valve.

Q. Okay.

A. So what that's for in the well, you go in and you set it. We can set it with electric line or we can set it mechanically. But you do have to have what we call a stinger sub to do the cementing through the

tool. And it is permanent, which means if you are going to remove it you have to have a percusion-type drill of some kind. We usually use a soft formation rock bit.

Q. Let's take it back. You go down with a stinger and you open the valve?

A. Correct.

Q. And you pump cement out through the bottom of the tool?

A. That's correct.

Q. And then you close the valve and let the cement set up?

A. Correct.

Q. So that's to form a cement plug in the well, typically the bottom of the well?

A. Well, no. There's several times that -- the purpose of this tool is manyfold. There's a lot of times the oil company will be producing a zone, and overnight the gauger calls in and says I was making 50 barrels of oil last week with two barrels of water. This morning when I gauged it, I was making 50 barrels of water and no oil.

Q. Okay.

A. Overnight that well didn't deplete. There is something wrong. Now, what it meant was water broke in from another source behind the pipe. So you will set

one of these and we pump into that formation trying to cut that channel off where he'll get back to 50 barrels of oil and no water.

Q. Now, what restrains the cement below the cement retainer?

A. Well, the packing system and the valve.

Q. I mean, what supports it below it? Is there another packer below it?

A. No, sir.

Q. I'm missing.

A. Everybody that's not used to these things, cement just follows, but we've got fluid below us.

Q. All right. But you're cementing the inside of the well and pushing cement out into the formation and cement job around the casing?

A. That's correct.

Q. Okay. And you let it set up?

A. That's correct.

Q. And then drill it out?

A. Drill it, the cement that's below it, through the formation, go reperforate it and see what we've got. That's one use.

Q. Okay. All right. I understand. And these cement retainers, what kind of pressures are they experiencing?

A. Okay. This Figure 1 was built for 10,000 PSI differential in either direction.

Q. And if you have formation pressure, you set this in there and then you push the cement through it against the formation pressure?

A. That's correct.

Q. I see. And I believe you told me that the Figure 1 has a mandrel that's loaded in tension when it's set?

A. That's correct.

Q. And that the mandrel cracks or comes apart if the thing comes unset?

A. Depends on where it parts.

Q. Okay. It parts during the tension part, it comes apart?

A. Well, no. There's several areas that is the weakest link and I -- we didn't have problems with the steel mandrels.

Q. No, I understand. I just wanted to understand where you had told me that the -- when you had the single set of double directional slips and two seals, you have a mandrel that holds the seals in place through tension?

A. Sure. Yes, sir.

Q. All right. So you built a few of these, and

I'm not trying to characterize the number, 20 or 30, and tested them in customer wells and found out they took a while to drill out as compared to the Pingo product, so there was some discussion about doing what?

A. Okay. The second thing that they requested was their -- Louisiana had some wells that didn't need a 10,000 PSI tool. They could have a tool -- a cement retainer that would -- if we could get it to operate at 5,000, then they would be satisfied. And they said through the marketing and everybody, it's got to drill quicker than the Pingo. So what they were giving us is, look, you don't need all of this 10,000 PSI materials and things that would hold 10,000 PSI. You've got money left in your AFE, let's build figure number -- whatever it was -- Figures 13 and 14.

Q. All right. And that was the second metallic one?

A. That's correct.

Q. And that's the --

A. 5,000.

Q. -- cheap version but it's 5,000 pounds?

A. Right.

Q. Maybe I'm confused, but you built those and they were easier to drill out?

A. Yes, sir.

Q. And that one also looks to me like the mandrel is in tension to hold the seal in compression?

A. Really, if you look at that aspect, it's the top of the other figure.

Q. It's half of the Figure 1?

A. Yes. It's half of Figure 1.

Q. Okay. But my question is that that mandrel was also in tension?

A. Correct.

Q. All right. And were those successful and y'all were installing them, or did you have problems with them, too?

A. No, they were successful as long as they were kept in their specification.

Q. Meaning less than 5,000 pounds?

A. Yeah, 5,000 or below.

Q. And what happened if they went above? You piqued my interest.

A. Well, there were several occasions that I was called to Louisiana with a failure. Now, once you set these, they are permanent. I can't go look at these things. And we pulled all the pump charts, and all the hydrostatics, and all of the things that comes up with a differential pressure. They exceeded the limits of the tool. And what happened, the weak point -- I mean, we

built it. We know the weak point with calculations. They parted the mandrel at the top.

Q. This is on the Figures 13 and 14 ones?

A. That's correct.

Q. Okay. All right. But those drilled out faster because it was half the size?

A. Half the length.

Q. Okay. All right. What was the next thing you did in the development of these cement retainers at Western?

A. Okay.

Q. Let me back up. What was the time frame of the metallic work? Is Figure 1 and Figure 13 all metallics?

A. Well, let me read because that -- let me see, I had Richard Sukup in charge of the project.

Q. You told me he left in '84?

A. Yeah, or '85. I'm going to say '84.

Q. All right.

A. Yeah, he left around '84 and went to work for Mobil. Now, what happened was we -- Western started having bad financial problems at this time, some serious financial problems. And the company, about the time that second retainer was going to the field and being proven, financially came to a halt, I'm going to tell

you.

Q. Okay. So give me a rough time of Western starting to have financial trouble and the Figure 13, Figure 14 cement retainer going to the field.

A. Okay. I can remember Richard -- he was one of my best engineers -- in '85 I said go find you a job. I gave him a hint and helped him, and he went to work for Mobil over there in Dallas.

Q. So these cement retainers, this part of the work was completed, say, by '85; is that fair?

A. Yes.

Q. You keep looking at your declaration. Do you have any documents or anything we can refer to to fix these dates, Mr. Harris?

A. No, sir, I don't.

Q. And is this just totally your recollection?

A. Yes, sir.

Q. Okay. And how did you get those dates in your declaration? And I guess we're talking about the declaration you gave to Weatherford?

A. Well, the only thing that I could base -- without having the documentation, which is impossible to get -- is based on Richard's employment, because I knew when he was hired in, or mainly when he left the company, because he was the senior project engineer I

had assigned to this project.

Q. Well, let me lead you a little bit so we can get on through this. I believe you told me you called Richard and he told you when he left. Is that right? Richard Sukup.

A. Right.

Q. And it was '84 or '85, and you recalled that the metallic work was completed before he left?

A. Yes.

Q. All right. And that's how you came up with the dates that you put in the declaration?

A. Yeah.

Q. Correct?

A. Well, no. Along this period of time Richard was also working the engineering work for a composite.

Q. Yeah, I understand that.

A. Okay.

Q. I'll get to that in a minute.

A. Okay.

Q. But the dates that you have in your declaration were based upon your conversation with Richard about when he left?

A. The best of my ability. That's the best I can do.

Q. And I just wanted to know or try to establish

or find out whether there was some document you looked at other than your recollection and Richard's --

A. No, sir.

Q. -- to prepare the dates in your declaration that you gave, and there's not, is there?

A. No, sir.

Q. Okay. That's fine. So I guess you were saying that Western was having financial trouble?

A. Correct.

Q. And you went to get a supplemental AFE or had a supplemental AFE? Explain this to me. What was the next thing you did?

A. Okay. The original AFE was to cover Figure No. 1. So I went in and asked for a supplement because I had enough marketing people with the drillability problem to go in and ask for a 13.

Q. Okay.

A. So I had to have a supplement written to that original AFE because it was going to require man-hours and machining and so forth.

Q. And I believe you told me when you finished the work on the Figure 13 under the supplement you still had some money left?

A. That's true. I was out of people and had a little money left.

Q. But Richard was still around?

A. No, he's gone.

Q. Well, I want to talk about the attempt that you made to make the nine and five-eighths all-composite cement retainer. When did that occur? Was that after the metal?

A. Along with it.

Q. Along with it?

A. Yes.

Q. All right. So during the period from '80 -- or up until '85 or '84, you and Sukup were working on an all-composite cement retainer?

A. Yeah.

Q. And how did you get funding for the all-composite?

A. The same AFE that was written originally for Figure 1.

Q. And certainly you and Western realized that developing an all-composite retainer was a different ball game from the metal one, didn't you?

A. Oh, absolutely.

Q. How did you convince them, or did they convince you, to build an all-composite?

A. Okay. When we started these projects, Western wasn't in a problem and money was flowing everywhere.

Q. Right.

A. The oil field was booming. So what we did was, when I went in with the AFE, there was a program in place with Western that we allowed each engineer to have a blue-sky project. We wanted their abilities and to help morale and sometimes we came out with good products.

Now, what we did was, we -- my engineers in my department would present their blue-sky project, and what I would have to do is -- I couldn't go get an AFE written for the blue-sky stuff. It wouldn't fly with the board. So what we did was -- and this was from the CEO down -- was we would include that blue sky into another AFE. It was written, documented and everything else.

So when we started looking at the real future and what would make a lot of money, we realized right quick that the composite would be an obvious big boost for the Western Company. We did some marketing on it and everything else.

Q. What are you talking about, marketing research?

A. Yeah. You're asking how did I get the money. Well, not only did I go in under that program, but I went in there with a good marketing survey saying this

is going to be a heck of a product.

Q. "This" being?

A. The composite.

Q. So who was in the management line that you -- did you go to a veep or who did you go to?

A. Okay. My first line was the -- wasn't even the director of engineering. It was -- I'm having trouble here. Just a minute. What would it be if all -- the manager of engineering -- the total manager -- the manager of research, manager of international answers to a guy before the CEO. What would be a normal -- anyway there's a gentleman --

MR. STEVENS: Director or vice president typically.

Q. (By Mr. Booth) It could be a vice president or it could be a president. Okay. So you went to a vice president and said, hey, there's been a long-felt need for something that you can drill out and composite in the industry; is that correct? Or did you not believe there was a need for it?

A. No. What we did was we prepared enough information to when I said that, that I could get the blue-sky money in with this and show that we could make money off of this project.

Q. Tell me what you mean by "blue sky," Monty.

A. Well, again, what we did was once a year Western would let, like, my group -- I have to talk for my group.

Q. Sure.

A. Okay. They would come in -- and I would have our priorities for projects, the field stuff.

Q. The meat and potatoes of the business?

A. Right.

Q. All right.

A. Okay. Now, each one of my senior project engineers would meet and they would have a proposal that says, man, I would like to do this and it's brand-new.

Q. Okay. That's what you mean by blue sky?

A. Yeah.

Q. It's a dream project?

A. It's a dream project.

Q. I see.

A. And we used it for morale. We used it for -- obviously we -- some of those products paid off big time. So to tie with blue sky, you can't write a blue sky AFE at the time, so you included it with a, quote, project the guy was on.

Q. I understand.

A. Okay.

Q. So that all-composite was the blue sky of

engineering -- all-composite tool?

A. Of Richard.

Q. Of Richard?

A. Mine and Richard's.

Q. Okay.

A. But it was my department.

Q. But to include it and sell it you had to tell them, boy, if you do this, what?

A. Well, it was revolutionary. I mean, when we started on this project --

Q. "This" being the all-composite?

A. All-composite. -- these rigs were getting anywhere from $250,000 a day down to 100,000. So when you ran the regular steel models and took four hours, it wasn't the product, it was the cost of the rig for you to do that. So if we could come up with a tool that would do the same thing, and do it in one-tenth of the time, we can save $100,000 sometimes for a customer. And we're going to get the business when we do that. But now we've got to make it work. So the main selling on this thing was drillability. That was the main thrust.

Q. Your sale to management, if I'm understanding was, if I can make a composite tool it will revolutionize the industry. Is that what you're saying?

A. In that tool, yes. In that retainer business, we will put the others out of business.

Q. And you felt like it was going to have a tremendous success?

A. Well, there's a story there, too, but --

Q. At the time you felt like it would be --

A. Absolutely.

Q. So that's how you sold it to management, it's going to solve a long-felt need and it will be a tremendous commercial success for the company?

A. Correct.

Q. Okay. Tell me what you did in your research and development of the -- I believe you told me at some point you ultimately built three of those all-composite cement retainers?

A. That's correct.

Q. Tell me how that went.

A. Okay. When I turned the project over to Richard, he was simultaneously refining this one --

Q. "This one" being the metallic?

A. The metallic. And a lot of the components were going to be the same design-look as the metallic in the composite.

Q. Same size?

A. Same size.

Q. So what you were going to do is just use the same prints basically to build a non-metallic or a composite?
A. Yeah, and change some items that ultimately wouldn't work, strength was not there.
Q. You can't just take --
A. No, you can't just go right across the board.
Q. You can't just replace the metallic part with a composite, right?
A. Yeah. We knew that.
Q. Okay.
A. So Richard started the design, and we went to Salt Lake to Environmental Resources that do the big molding, and built molds for the size nine and five-eighths for the components that we call critical components.
Q. That would be?
A. The pressure vessels, the bottom guide -- there's some things in here that we -- but the mandrel itself, we just took -- they molded us a slug, we called it, of this 610 nylon, and we actually machined it to the shape, form, the whole deal.
Q. Okay. At one point you told me that the critical components on this tool were the mandrel and the slips?

A. And the lower guide.
Q. And the lower guide.
A. Yes, sir.
Q. Now, to build the mandrel on this all-composite cement retainer, you took a slug, which is a solid cylinder of material, and turned the outside to the size you wanted it?
A. Yeah. And drilled the inside.
Q. They drilled a bore through the inside?
A. Yeah. It was solid.
Q. Okay. All right. I believe you told me that ultimately you tested it and the product failed; is that correct?
A. Yes, sir. We had several failures.
Q. And in your own words tell me how the testing went and what happened.
A. Well, what I was going to say a while ago, and this is the proper place to say it, is at the time we had worked -- we had talked to Bell Helicopter, and everybody that used composites -- the strength that was needed in the composites for a size nine and five-eighths was just not available.
Now, let me explain that. When you put pressure on a larger item, there's more force. F equals P times A. And when you computed that information in

the design, it was higher than the yield strength of the material. So we were crushing and breaking, and anything you would expect when you go over the yield of the material.

Now, where I made the mistake when Richard was working on this, was I should have said, Richard, I'm going back to management and I'm going to change this size to four and a half or five and a half, or get it smaller where now these forces are in the limits of this 610 nylon that we're using. And if we had done that, we would have had a tool.

So the failures were numerous --

Q. Well, just take me through it chronologically.

A. Okay. The first failure we had was obviously the mandrel for pressure vessel.

Q. What happened?

A. We were designing this for 10,000.

Q. Okay.

A. I would get it to about 7500 to 8000, it would split.

Q. Is this after it was set?

A. Yes, this is -- we didn't have any setting problems with it. The second problem I would have had is when I would shut the valve, and pressure below it, I

would start crushing the cones.

Q. The slip cones?

A. Yeah. That's the wedge that hold the slips out.

Q. Okay.

A. So we saw right quick that, hey, let's shut this thing down. Again, Western is tapering off here with money problems. I said, Richard, let's combine this now, and let's put some steel components in here and see if we can get this thing half and half to work.

Q. Okay. Before we go into that phase, let's back up a minute.

A. Okay.

Q. You told me on the phone -- and if I'm misremembering what you said, correct me -- that the slips themselves also failed on you?

A. Yes.

Q. And that when you applied pressure to the tool, it would just pump up and down the well? It wouldn't even stay in place?

A. Yeah, we had a couple of them do that. Yes, sir.

Q. And the slips were -- the buttons or whatever you had in them were pushing through the slip?

A. That's correct. The body of the slip, they

were.

Q. Okay. And then I didn't know, but the cones also were crushing on you?

A. Yes, sir.

Q. So those two were related problems?

A. Right.

Q. Now, that's not a pressure issue, it's just --

A. It's a force issue.

Q. So it was just too much force on it? Okay. I believe you told me you guys ultimately concluded it was really just a failure? Is that what you said?

A. That's correct.

Q. That's what you believed?

A. Well, Richard, I told him to go get a job because everybody was fixing to get laid off.

Q. All right. Now, are there any documents or records that you have regarding this nine and five-eighths salt composite testing program there at the company?

A. Well, let's put it this way: The company went bankrupt. B.J. bought the company, and I left -- I was the last engineer to go.

Q. Okay.

A. So I don't have a clue what they kept.

Q. I don't care about them. I'm talking about

you.

A. No, I have no documents.

Q. You have no documents, and you're just telling us what you recall? There's nothing you're looking at?

A. Oh, yeah. You carry a document out of Western and they'll put you in jail.

Q. All right. And I believe you told me that this whole test program at Western on the nine and five-eighths was a secret program going on in the company? That you weren't talking to the industry about it?

A. Well, let me tell you this. Okay? I was also chairman of the patent people.

Q. Okay. The patent committee within Western?

A. Yeah.

Q. Okay.

A. And we had an internal magazine that had a new product section in it, because we had chemicals and all kinds of things. The only thing that I can remember going into that publication -- because we had to be very careful with these patents -- of what I was doing because of the years and all of these sort of things, we had an internal document that said something to the effect that we are researching an all-composite tool, period, nothing else.

Q. Let me quantify this. During the entire time you were at Western and worked on the various composite tools and part composite tools, that's the only published notice of that work that existed, and that was in a company internal newspaper; is that correct?

A. Yeah.

Q. Other than the patent itself, the '202 patent, right, if that's what's troubling you?

A. No, I can't recall nor I would know if World Oil had a public -- or anybody.

Q. But you had told me that this R&D -- and I had asked you why the other engineers in the industry didn't know about it, and you told me it had been kept a secret at Western?

A. Absolutely.

Q. Yes. And both the nine and five-eighths and the two and the three-eighths that we're going to get into and the part composite were all kept secret at Western; is that correct

A. Yeah. For a bunch of reasons, yes, sir.

Q. Good reasons being you don't publish your research to the industry?

A. That's true.

Q. And I believe you told me that of the nine and five-eighths, you never drilled one, the all-composite,

because you couldn't get it to stay in the well long enough to drill it?

A. Right.

Q. You don't have facilities to drill in-house?

A. That's correct.

Q. And this was all tested in-house, correct?

A. That's correct.

Q. And there was never a part -- it never reached the point where it was ready for patenting or manufacturing, the nine and five-eighths? I want to be sure we're talking about one tool at a time.

The all-composite cement retainer R&D program never reached the point where it was passed on to manufacturing or ready for patenting? The all-composite.

THE WITNESS: Well, Lou, you look at this for me because I don't remember -- somewhere down here -- I don't have my reading glasses with me -- we talk about drillability and a composite.

MR. STEPHENS: Okay. Let me read this.

THE WITNESS: Sure.

MR. STEPHENS: I'm quoting now from the first page of the '202. "To facilitate drillability, components of the tool are formed of a synthetic resin composite, specifically a polyamide material that is

glass fiber filled at a level of a minimum of about 30 percent of weight, having an extremely high codulus of elasticity and having a heat deflection temperature of about 400 degrees Fahrenheit fully loaded."

Is that what you're referring to?

THE WITNESS: That's what I'm referring to.

Q. (By Mr. Booth) I'm aware -- you told me about the '202 patent and we've been through that. But my question is at Western the nine and five-eighths never was ready for manufacturing because it was a failure, correct?

A. Well, I guess what I'm trying to say is during this period of time we had written some things before the thing really started failing.

Q. I don't understand.

A. Okay. When we're doing the patent on this --

Q. The '202 patent?

A. The '202 patent. Okay. -- we get our patent attorneys and we say, look, we're having failures with this salt composite. However, we feel like that certain sections of this all steel one that, quote, are noncritical, we can use a composite.

Q. Certain sections, you mean components?

A. Components.

Q. Yes.

A. Now, whether we do or we don't, we put it in the patent.

Q. Okay. So with that footnote that -- let me see if I can paraphrase what you said. When you and the patent committee went to the patent attorneys, you said we don't want to file on all-composite, and you specifically left it out of the patent, didn't you?

A. Well, gee whiz, let me think here a minute.

Q. Well, let me take it back. You told me -- and maybe I don't remember. But you told me on the phone that you left the all-composite out of the '202 patent because it didn't work; is that fair?

A. Well, yes, sir. But let me explain that. You can patent things that don't work. You can patent ideas and things like this. Now, what we did, the reason we didn't file a patent on the all-composite, we didn't want the other companies knowing what the heck we were doing.

If you want to file a patent and give your research away, then that's what you do. So as the chairman of the committee, with the patent attorneys, this great idea that's going to make millions and millions of dollars, we're not going to file it right now because we're going to give our research away.

What I'm going to do is I'm going to try to mix in enough composite that if we may have a prayer that we -- I'm not telling them how I did it, I'm just saying that this is why we did it and this is one of the claims.

Q. Well, I think we've gotten out of order because we haven't gotten into the part composite/part metal.

A. Right.

Q. That's the next one. There's just two more tools I want to cover. I'm trying to dispose or finish up on the all-composite.

The critical components failed on you, and you didn't want to put it in the patent because you didn't want to disclose the research, and that was intentional, that you left it out on purpose, correct?

A. Correct.

MR. STEVENS: Is this a good time to just break for another 10 minutes?

MR. BOOTH: Sure. Let's go off the record.

(Recess held)

MR. STEVENS: We have been taking these breaks in part due to mental fatigue which Monty experiences. He has expressed concern to me during the

break, and we've had a brief conversation off the record now with Mr. Booth, regarding the causes of that fatigue and Monty's concern about being confused.

When Monty attempts to integrate sequences of events or talk about multiple issues, he gets confused, and is concerned that he may have said some confusing things, although he's trying his best to be clear.

So we just want to put on the record that Monty is doing his very best, is concerned about some possible confusion, and we'll try not to get the confusion as part of the testimony he's giving here today. But we do have to be careful and watch his condition and let him have his breaks and let him say he's confused when he's confused.

Q. (By Mr. Booth) When we took the break -- and again, Mr. Harris, if you get to feeling bad or it gets too tedious, let me know and we'll stop.

A. Thank you.

Q. I understand this is hard for you. We were finishing up with the all-composite cement retainers. And which one of the designs in the '202 patent, referring to a figure, was the nine and five-eighths composite retainer like? Was it like the Figure 1?

A. Yes, Figure 1.

Q. Okay. And you told me on the phone that one

of the load factors in the failure of the mandrel was the fact that that mandrel was under tension; is that correct?

A. Correct.

Q. Now, let's move on to the next product I believe you told me you worked on at Western, which was the part composite and part metallic cement retainer, where you blended both the metal and the metallic together.

You started to tell us a while ago and I stopped you, but you and Richard decided to try to salvage something out of the failed nine and five-eighths composite cement retainer, correct?

A. That's correct.

Q. All right. What did you do?

A. We picked the components on the metal retainer that is what we called noncritical. It's a noncritical component. These components were in the engineering calculations that they would work under these force loads. So instead of abandoning the total composite idea and losing the patent totally, what he did was he made some components out of this 610 nylon reinforced, and we supplemented those components on the steel model and tested them.

Q. Let me paraphrase and be sure I understand, or

summarize. I believe you told me on the phone you did, like, four of these?

A. That's correct.

Q. And you salvaged some metal parts off of the metal project, like the mandrels, correct?

A. Okay. Say that again.

Q. Where did the -- as I understood this, the part composite/part metallic had a metallic mandrel --

A. Correct.

Q. -- metallic slips, and was it metallic slip cones? The critical components, if you recall.

A. I don't -- you hit two of them, I know that.

Q. Let's just put it this way: The slip cones could or could not have been metallic also?

A. Right.

Q. But the rest of the parts were composite and rubber, and some brass pins?

A. Yeah, except the lower guide, the bottom piece.

Q. Which was also metallic?

A. Yes.

Q. That's the part down here where the 60 is?

A. Yes, sir. It is a pressure container critical component.

Q. Okay. Now, my question, is these metallic

parts, did you just take them from the other project or
did you have special ones machined?
A. I don't remember. Richard did that.
Q. Okay. And the composite parts -- the same question I have about the nine and five-eighths cement retainer -- did you just take the composite parts off of that project and --
A. Yes, sir.
Q. You didn't make new parts?
A. No.
Q. Okay. So you don't know whether -- and I guess I'm reaching out here. You don't know whether the metallic parts needed some additional machining to them to get them to fit the nonmetallic parts that were on the part nonmetallic cement retainer?
A. No. That was one of the things that I talked to Richard about, said let's don't spend no more money. If they'll fit, use them. If they don't fit, don't use them.
Q. I see. So your best recollection now is that -- if I'm understanding what you're saying -- is that the metal -- metallic mandrel was the one from the nine and five-eighths all-metallic retainer?
A. Yes, sir.
Q. And as I recall you told me you took the part

metallic and the part metal one, the one we're talking about now, and you tested some of them?

MR. STEVENS: Part metallic and part composite?

Q. (By Mr. Booth) Part composite. I didn't make myself clear.

A. Yes.

Q. These four you tested, you didn't have any way to drill them out?

A. No, sir.

Q. Or test the drilling time, correct?

A. That's correct.

Q. You never went to manufacturing with them?

A. No, sir.

Q. But you did include them in the '202 patent, or some of it, correct?

A. Yes, sir.

Q. Okay. Other than the '202 patent, yours and Mr. Sukup's patent, was there any publication to the trade or industry of the work that you did on the part composite/part metallic cement retainer?

A. No.

Q. All right. And tell me how -- you were going to get into this. You were on the patent committee. You were the patent committee chairman, as a matter of

fact?

A. Yes, sir.

Q. How did you decide, with the attorneys, to include or not include the work you had done up until the time the patent was filed?

A. I hope I understand this. What I did --

Q. Sometimes there's a bad question and nobody can ever understand it, Monty.

A. -- is we wanted to include as much in the patent as we could that would talk about the composite, but I didn't want to put all of this research into it and dwell on this being a composite tool because I didn't want the competition to really catch on to this.

Q. Okay.

A. So in the meetings that we had was is, let's write this where this is a different type cement, or even the metal ones, let's write it like it's all metal. However, let's put in there when it's appropriate the nomenclature of the wording of the composite without giving the project away.

Q. Was that with the patent attorneys or was that done in your committee?

A. Well, it ended up in the patent attorneys.

Q. I mean, you talked to them about what to leave in and what to include?

A. Oh, yeah.

Q. That was Catropia and those guys at that real good firm there in Dallas?

A. Yes, sir.

Q. And at some point you went ahead and filed the '202 patent? I don't want to get out of order but -- correct?

A. Yes, sir.

Q. And you and Mr. Sukup were on it as inventors?

A. Yes, sir. That's correct.

Q. On the all-composite cement retainer that you developed for -- or that you tried to develop for Western, why didn't you -- and I know I asked you this before on the phone -- why didn't you just use the old Baker tension packer? Why did you go design something new when you had the old Baker tension packer you could use?

A. Well, this is a cement retainer and the other is a packer. It's two different totally -- they are used for two different purposes. One of them -- I mean, this is something that I think you and also Weatherford haven't fully understood yet.

Q. Okay. Explain it to me.

A. Maybe I'll use a scenario.

Q. Okay.

A. You own a ranch, and you're going to clear big oak trees, you are going to hire a Caterpillar, a dozer.

Q. Okay.

A. You are going to pave the driveway. There's different equipment totally that you use. One is appropriate for one thing and one is appropriate for the other. So therefore, you can't take the paving equipment and go out there and knock oak trees down and clear your land. It just won't work.

So these are two totally different pieces of equipment. However, when you talk mandrels, now, that is a term we use in all kinds of packers and retainers.

Q. What is your definition of a mandrel?

A. It's the main body pressure vessel in any tool.

Q. Does it have to be hollow?

A. Does it what?

Q. Does it have to be hollow?

A. No, sir.

Q. So it's the tubular body, is that your understanding of the term?

A. Yes, sir.

Q. Okay. The other thing I noticed and I asked you this, you know, when you file a patent, you have a duty or the law requires that you tell the patent office

about all of the prior existent relevant things that --

A. Correct.

Q. And you didn't tell the patent office in your '202 patent about any of these prior Baker tools, correct?

A. Absolutely not. It's not the same tool.

Q. And the reason it's not the same tool, it won't function the same way; is that correct?

A. That's correct.

Q. Could never be used to set downhole and be drilled out?

A. No, it is set downhole and drilled out.

Q. No. I'm talking about the difference between the Baker was a tension packer that was supported from the wellhead and couldn't be left alone downhole by itself to function as cement retainer or bridge plug or anything else. Is that a bad question?

A. Yeah.

Q. Okay. Let me try again.

The reason you didn't think the Baker was relevant was because it wasn't a self-supporting tool that you could leave set downhole and do whatever functions you wanted to do with it?

A. Obviously that's some specifics. But any tool engineer, if you ask him that same question, will say

you're not even talking about the same thing.

Q. Okay.

A. I mean, why in the world would I worry about that --

Q. The problem is that you and I -- I mean, I know what you're saying, but maybe someone who is not as versed in this field wouldn't know when you just say it's different, it's just like the difference between an elephant and a camel, they don't understand what we're talking about. I'm trying to get your own words about that.

But one was designed for corrosion and the other one was designed for drill-out, correct?

A. Well, here's another thing, too. That's very good. One is a service tool and one is a production packer.

Q. You told me that before. And service tool is something that you take back out of the well?

A. Or drill it out or whatever.

Q. Okay.

A. It comes with a man, let's put it that way.

Q. All right. So you included whatever you wanted to disclose in the '202 patent and everything else you held back, you kept within Western, correct?

A. Correct. Yes, sir.

Q. And you were going to work some more on that. And you and Mr. Sukup filed a patent on May the 7th, 1984, correct?
A. Well, it's July 8th, isn't it?
Q. Well, that's the second. May 17th is when you filed the first time?
A. Okay.
Q. Is that correct?
A. Yes, sir.
Q. And by that point in time I think we have a benchmark in time, you had finished work on the metallic that you described, and you had finished the failed attempt on the all-composite, and you guys had tried to salvage some metallic composite tools?
A. Yes, sir.
Q. So by that time.
A. Yes, sir.
Q. And did you tell me on the phone that you also experienced some difficulties with the part metal/part composite tool, the four that you had?
A. We think we've covered that, but yes, sir.
Q. And what was that?
A. Part metal and part --
Q. The metal mandrel, metal slips, metal slip cone that you built with the rest of it composite.

A. Yes, sir, we had some crushing of the cones because of the force loads.

Q. Okay. And I know you had that on the all-composite, but you also had that on the part metal/part composite?

A. Right. The problem didn't go away, don't matter which one we had.

Q. Okay. All right. Now, Sukup left. What was the next thing that happened in the R&D program at Western regarding composite tools or downhole tools?

A. Okay. At this point Western was on a steep downhill decline in Chapter 11.

Q. "This point" being at about the time the patent was filed?

A. No. About the time Richard left.

Q. So maybe a year later?

A. Maybe quicker than that, because I told Richard to go find a job quick.

Q. Okay.

A. I remember telling him that. So virtually any expenditures stopped in the whole company. You had to have a tremendous reason for having expenditures. We had massive layoffs, auctions. I mean, this was a disaster. So I ended up, me and two other guys, the only engineers left in the whole company.

Q. I believe you told me the other engineer was putting trucks together and he wasn't even working with you, right?
A. Yeah, that's true. And then we had one guy for offshore. He was in Houston.
Q. But in terms of the R&D engineering department, you were it?
A. I was it.
Q. Okay.
A. Now, it came to a point that they started calling in all AFEs and they were -- and that includes the field. I'm talking about the districts all over the United States.
Q. By calling in the AFEs, they're saying you can't have the money any more?
A. Where are you, do you have a contract with a machine shop, and we're cutting the money off, period.
Q. Okay.
A. Okay. Now, there was a few times that if you had a justifiable response, you had a prayer of keeping your money. Okay?
Q. But blue-sky programs were out by this point, weren't they?
A. Well, yes. But we had -- remember me telling you we had started this composite under the steel

model.

Q. I see.

A. Okay.

Q. Under the left-over money?

A. Yeah. On the supplement.

Q. Okay.

A. So I'm sitting here now with a supplement to the original AFE, like $125,000. So I go into James Hughey -- that's his name.

Q. James?

A. Hughey. He was our VP of the division, whatever. And said, look, here is a project that I really want to go ahead through the patent stage and everything else. Can I have that hundred and whatever it was to finish this? It's already in the AFE supplement.

Well, it's pretty obvious this man didn't care no more because he's fixing to get laid off, too. He said, Do whatever you want to, but I'm going to tell you right now, it can't show up on paper.

Q. You're telling me he said keep it a secret because?

A. Well --

Q. And we're talking about within the company, right?

A. Yes.
Q. Keep it a secret in the company?
A. He said -- in other words, if I went and spent money on this two and three-eighths size, it had to show up in the AFE as this nine and five-eighths that we had been working on --
Q. Okay.
A. -- the supplement. So I've got permission now to spend the rest of the AFE supplement.
Q. What pitch did you give to him to get him to let you keep the 125,000 to develop with?
A. Okay. I'm going to do some speculation. Okay. When this company was headed for Chapter 11, they were obviously trying to sell the company. And it was on the market, quote, both before and after Chapter 11.
Q. You think this was in the mid-'80s in time?
A. '86, yeah.
Q. Okay.
A. Now, to make a sale of a company that's going Chapter 11 look good, for no other -- I can't think of the word -- it is always nice to walk in with some research projects that are worth a lot of money. And we had some chemicals that we had patented and we had other things. So he could walk in, or management to be that's trying to sell this company, with a package, and one of

them would be a composite, okay, which B.J. loved it.

Q. Okay. So what do you recall saying to him about -- reminding him of this project and what value it would have?

A. Well, obviously I told him there's no more patent committee. I'm it. And I've gone through Catropia's patents that are underway, the cost analysis, the whole deal, and I've narrowed this thing down to a couple of patents. If you want to stay -- if you want to patent this stuff, then here is two or three I laid out, and this is one of them.

Q. Okay. '202 was one of them?

A. The research on '202.

Q. All right.

A. And I said, I would like to finish this project, so to speak, because I think it's going to have future worth beyond what you can realize.

Q. And that means good?

A. That means good.

Q. Okay.

A. And I said -- of course remember, this was all prepared properly. I said, Mr. Hughes, let me take that supplement money and let me build a size of plug that I know will work.

Q. And you were thinking about the '203?

A. Yeah. It was in the force loading range and I should have done it first.

Q. And so at this point in time, which is a little later than when you start the nine and five-eighths, there was still a tremendous need out there for a composite tool?

A. Absolutely. Still is today.

Q. And you still thought it was a tremendous value to the industry?

A. Absolutely.

Q. All right. And so he said to you, don't generate any paper and don't tell anybody?

A. That's correct.

Q. And you told me on the phone that was because if somebody found out you were spending money on a long-shot or a blue-sky project -- is that right?

A. Yeah.

Q. -- there would be other employees --

A. Also Mr. Hughes, the guy that stopped all the other AFEs --

Q. Okay.

A. So in other words, he couldn't have engineering working on an AFE when he stopped all the districts and everybody else. I mean, he -- it wouldn't be nice.

Q. All right. So you then got his approval. Did you follow his advice about no paper and keeping it a secret?

A. Okay. Let me explain "no paper." Nowhere could I write down two and three-eighths. Nowhere, sizewise.

Q. Okay.

A. If I built something, it had to be prefaced, or management summary, whatever, nine and five-eighths. Because all the marketing that had been done and that's what the original AFE supplement was written on. So to clarify, I guess what I'm trying to say is I did generate paper, but it was not anywhere on the two and three-eighths. I mean, I had to go to machine shops and I had to get bills in and I had to do things, so yes, there was paperwork.

Q. But up at the top it said nine and five-eighths project?

A. That's correct.

Q. But nowhere could you look through this paper and see anything to do with two and three-eighths?

A. I was told not ever to do that.

Q. And did you follow his advice?

A. Absolutely.

Q. Okay. So as I recall you said you built two

of them, or had two of them built?

A. Two.

Q. They were out of nylon?

A. 610 reinforced nylon, yes, sir.

Q. Your declaration makes reference to a drawing of that part. I believe it's supposed to be Attachment A. Did you ever get a copy of that sketch?

A. No. Do you have it?

Q. No, I don't have it. You sent me a declaration without an Attachment A on it.

A. I didn't get it back.

Q. So Western has it?

A. Yes.

Q. Okay. Which one of these tools is the two and three-eighths inch like, was it the Figure 1?

A. Figure 1.

Q. It was the Figure 1 type?

A. But now, remember, it was a plug.

Q. Okay. We will get there.

A. Not a cement retainer.

Q. So to address that right now, you bought a cylinder of nylon material that you used for the center part?

A. That's right.

Q. And you never bored it out?

A. No. It was solid.
Q. And so you had a solid internal part, what you call a plug, correct?
A. That's correct.
Q. And you put threads on the top and a shoulder on the bottom?
A. Yes, sir.
Q. And where did you get the other parts?
A. Out of a machine. Totally out of slugs.
Q. Out of slugs. Okay. And I recall, there's a different history on the two tools. The first tool you built and you ran in the company test well?
A. That's correct.
Q. You did it yourself?
A. Yes, sir.
Q. And what happened?
A. I set it on what we call a wireline tool, a Baker E-4. I put it in the well, fired the setting tool off --
Q. Is it E-4 or E-5 if it's two and three-eighths?
A. It's E-5 maybe.
Q. Yes, I think it is.
A. You know, you can't see it. I heard the bump and everything looked fine. Well, when I pulled the

setting tool out of the well, I had the top -- one inch of the mandrel had sheared off instead of the shear device that was supposed to be sheared.

Q. Okay.

A. Now, this -- it was not a good thing. However, it didn't affect the pressure-holding ability of the plug.

Q. And had you set it in like a 10 feet -- or small section of tubing?

A. Two and three-eighths.

Q. How long a section?

A. Thirty feet. I would say probably in the middle joint -- middle of the joint.

Q. What else did you do to it?

A. Well, I ran a series of pressure reversals, because pressure from the bottom first, then the top, and then bottom and then the top, and took it to destruction until I -- well, it really started leaking. It didn't move.

So what I was doing was working these differential pressures to get a -- you know, I did an engineering analysis of what it would do, but this is the prototype and let's see what it will really do.

Q. I want to ask you, you didn't have any recollection on what exact pressures you used to run the

tests or any records of those tests?

A. No.

Q. And I guess if you were following --

A. I know it passed.

Q. Were you following his advice and not keeping records of this at the time?

A. Yes, sir.

Q. And I believe you told me you split the tubing and mandrel open just to look at it; is that correct?

A. Yeah.

Q. And you ran the test yourself. How did the -- let me back up. On the E-5 tool, how does that normally release from the part?

A. You have to have a shear device. You can't rotate it or anything because it's on wire.

Q. So like a shear pin or --

A. Yes.

Q. What did you have in yours?

A. Shear pin.

Q. Where does the shear pin go in Figure 1?

A. Well, you've got to put a solid mandrel in it first. I can draw it for you.

Q. Well, go ahead and explain it to me. I think I can follow you.

A. Okay. If you put that mandrel -- may I borrow

your pen, please. Thank you. If you put that mandrel solid -- I came in here and I drilled and tapped into the 610 nylon thread. Now, what I did, I screwed into this a brass bolt that has a predetermined shear area right here (indicating).

Q. Okay.

A. So when the E-4 or E-5 pulls to that designated shear value, this thing shears right here, you leave half of it in the well and you take the other half out of the well.

Q. All right. So first of all, the nylon plug that you had in the middle of this tool wasn't exactly like Figure 1? That's why --

A. No.

Q. -- it stuck out from the top and had some thread hole in it, right?

A. Yeah.

Q. Now, how did you select the shear strength of that brass shearable member? I guess screw you called it.

A. Okay. I had developed -- or we had developed the formulation for amount of force needed to energize the elastomer systems on these tools, and it was based on mass. So we could extrapolate from tests and engineering how much force was needed to energize that

tool, make it hold pressure. And then I had to go a little bit above that to -- that's what determined that.

Q. But at a force less than the tool would self-destruct?

A. Yes. Oh, yeah.

Q. As I understand these Baker setting tools, they'll go way up there in force?

A. Yeah.

Q. And so you have to have a shear device that exceeds what is necessary to set the tool but is less than what it would do to damage the tool, right?

A. That's correct.

Q. Okay. And so what happened, when you set the tool, the two and three-eighths tool, or plug as you call it, in the company well, you never reached the setting force which would be sufficient to shear that brass screw, correct?

A. That's correct. However, I must have got enough force in it because it did hold at differential pressure.

Q. But we don't know today what kind of pressures that you -- and we know that after you experienced or placed pressures on both sides of it, it began to leak? That we do know, don't we?

A. Well, I will say this: I know it was not over

5000 and it was not under 4000 because I did have a design limit, and I remember the design limit.

Q. Okay. And you told me that over the phone, you had design limit, but you didn't recall what pressures you put to this tool, correct?

A. No. The reason I'm even commenting on it is I remember I satisfied it.

Q. I understand.

A. If this thing would have held a thousand PSI and failed, I would have been very displeased with myself.

Q. How did it begin to leak? How did you know it was leaking? Your pressure would drop on the --

A. Well, it would not only drop, but it would show up on the other side and run out on your foot.

Q. Do you know at what pressure it began or how many cycles?

A. No, sir.

Q. And how bad it was leaking?

A. No. I was satisfied. I mean, I was -- the only thing like I'm saying is not only was I satisfied on pressure, or I was happy, I was happy with the cycling I put on it.

Q. All right. After the test, did you go back to the vice president and tell him?

A. No.
Q. I mean, at one point I think you told me that nobody would listen to you because you had broke the mandrel?
A. Well, you've got to remember here, these VPs were getting these golden parachutes and Mercedes and they were hooking them. Mr. Hughes was one of them. The people I started dealing with then were field people, district managers and things like this.
Q. Within Western?
A. Within Western.
Q. Yes.
A. Yes. I mean, there just wasn't anybody left up there.
Q. Let's go through this -- finish this two and three-eighths then. So you had a second tool that you had machined out yourself, correct?
A. I guess two at one time.
Q. Yes. And what did you do with the second tool?
A. Okay. The second tool, I was obviously distraught about what was happening to this project in Western. I couldn't keep records on it, which is not a good thing for a research project. I was -- my only thing left was in the normal process of these tools, you

do your testing in your test facility and then you take tools to the field and get what we call field runs.

Q. Field runs test some other factors, don't they?

A. Yeah.

Q. And so what were you wanting to test in the field?

A. Okay. I had made some changes where my mandrel parted. I couldn't set it in the well or I would have lost the tool because it's permanent. I would rather have a field run and test my little change I made --

Q. Maybe I didn't make my question clear. You're telling me that you wanted to see if the seals stayed on it because you were going to run them down the well?

A. Yes.

Q. Whether the slips would fall off, that sort of thing?

A. Yeah.

Q. That was part of the --

A. Field run.

Q. -- field run test that you wanted to run?

A. That's correct.

Q. In addition to the in-house test. Okay. And so I didn't know this, but you also changed the mandrel

a little bit after --

A. Yeah, I made that change.

Q. -- after it broke in the company well?

A. Right.

Q. Okay. So how did you get your field test run?

A. I had a good friend that was a district manager out of Crowley, Louisiana. And remember, I have to keep this quiet. So I asked him, I said, look, I need to get a run on this two and three-eighths tool I have, and told him what it was. And I said get one of your salesmen to find us a run in a well where this tool don't have to really do a lot as far as holding differential pressures. And I will give you the plug and you give it away, don't put it on a ticket. If you do, put no charge.

He said send me the tool -- see, he had tool people in his region -- or his district. And I said the only thing I want is a phone call. I don't want no paperwork. So I sent it to him. He got right on it. It was a plug and abandonment, which means all they did was set it, pull out of the hole and dump cement on it.

Q. Just for the record, a plug and abandonment is where you're just going to get rid of the well, you're going to fill it up with cement?

A. That's correct.

Q. And then you're going to cut the top off of it and cap it?

A. Yeah.

Q. So you go down and you set some kind of --

A. Plug.

Q. -- plug or blockage, and you don't cement and fill the well all the way up to the surface or --

A. Well, as high as the Railroad Commission requires.

Q. Why did you go to a plug and abandon?

A. So the thing didn't have to do anything, even if it failed.

Q. You were worried about it failing?

A. I didn't want to take the responsibility -- let's put it like this. Let's say I put it in a high visibility well where it had to hold pressure and it failed, paperwork now is going to be generated.

Q. Okay.

A. There would definitely be paperwork.

Q. So I believe you told me the guy was Cap duPonte, which is a friend of yours?

A. Yes.

Q. They put it in a plug and abandon situation, and Cap gave it to a salesman who in turn ran it?

A. No. The salesman didn't run it. The salesman

found a customer.

Q. Okay.

A. One of the toolmen delivered it out to the well and ran it on the wire -- E-4 wire line.

Q. And I believe you told me you don't know whether Cap was there, or the salesman was there, or who was at the well site --

A. No.

Q. -- when they ran it in the well. And you said it didn't have to hold pressure, it had to hold the cement for a minute, but even if seals leaked, the cement was there?

A. Yeah.

Q. Okay. And the report back was that it held the cement?

A. Well, I didn't get a report back and I got real antsy about it. I think I called Cap and I said, Have you run the plug. Oh, yeah, we ran it two weeks ago, something like this. And I said, Well, Cap, how did it work? Well, we pulled the top out of it. I mean, that's what my tool man told me. I said, Well, did it hold the cement? Yeah. The customer was satisfied. But he said we pulled the top out of it and he said, you know, about an inch of it and didn't shear the stud so it just -- what I did didn't fix it.

Q. So it still broke before it reached the brass shear strength -- setting strength?

A. Right.

Q. The customer was satisfied with the job or the plug or what?

A. The job.

Q. The fact the cement set up? The customer --

A. Well, what they do is, they use a bailer to put this cement on top of a plug. It carries in maybe five gallons on wireline. They'll dump five gallons and come out of the hole and mix another five.

Q. Okay.

A. Every time they went in, the cement was where they left it, which meant that plug didn't take off down hole.

Q. Right.

A. So they only had to hold weight of the cement.

Q. Until the first slug set up?

A. Until the first slug jelled. We call it jelled.

Q. Okay.

A. By the time they made the second trip, it was set up because they tagged it and sent it down that's the way it was.

Q. I have got to ask you about a couple of

statements that you made here in this declaration. And let me go quickly with you. The declaration that's signed 9/23/01.

A. You mean the supplement?

MR. STEVENS: The first one. First one is 12 paragraphs?

MR. BOOTH: Correct. Correct.

MR. STEVENS: 9/23/2001 date.

Q. (By Mr. Booth) Who prepared this declaration? Who typed it up?

A. I don't actually know the person, but in Weatherford.

Q. You didn't type it up?

A. No.

Q. You had an interview with them, like you did with me, and they prepared this document, which is the declaration you signed on 9/23/01, right?

A. Yes, sir.

Q. And I ask you before -- let's go to paragraph nine. Do you know who -- it says Cap duPonte gave the plug to a salesman for Western. Do you know who that salesman was?

A. No, sir.

Q. Do you know if he really actually gave the plug to a salesman? Because you said a while ago that

wasn't true.

A. No. He gave it to a tool man.

Q. All right.

A. He would not hand that thing to a salesman. The salesman doesn't even know where he's at half the time. They play golf.

Q. And the next paragraph says the plug was set by a wireline company. Who was that?

A. I don't recall.

Q. Do you know?

A. No.

Q. And the plug was successfully set in the well and performed as required, and that means that it supported the cement long enough for it to set up?

A. Correct.

Q. Anything else it performed successfully other than that to your knowledge?

A. Yes. It told me nothing fell off of it as I ran it.

Q. Okay.

A. None of the critical components fell off.

Q. Okay. And it says the setting process utilized too much force and a portion of the mandrel snapped off.

A. Right.

Q. That's not correct, is it?
A. Well, you can interpret that -- what it is, if I would have lowered this force here -- see, there's a happy medium of getting the work done and shearing. And you can't get them real close because let's say I sheared this and I didn't have the energization done, then the plug won't work.
Q. Well, did you believe that the brass shear screws were failing, that they weren't acting right?
A. No.
Q. So you were applying the exact amount of force that you intended to?
A. Yeah. It was shearing at a different place. Oh, yeah.
Q. So the failure was in the plug?
A. Mandrel.
Q. Okay. And then in paragraph 11, have you had a chance to read that?
A. Okay. (Witness reading) Was not required. Okay.
Q. Do you know that?
A. Well --
Q. I mean, you told me you didn't even know it was there?
A. Well, I'm reading this as the disclosure

agreement, something signed.

Q. Yes.

A. Well, I didn't have any paperwork so I have to assume there's no paperwork.

Q. You can make assumptions, but you can't state as a matter of fact that the customer and the people at that well site weren't told to keep this a secret either in writing or otherwise, and probably were, were they not?

MR. STEVENS: Do you understand the question?

THE WITNESS: No.

Q. (By Mr. Booth) No. Okay. You had told Cap that you wanted no paper and you wanted this to be kept quiet, right?

A. Correct.

Q. And in fact, you said at one point you had seen the job ticket and it didn't mention anything about this two and three-eighths inch plug, and you told me that you assumed that Cap had followed your advice to keep it secret, correct?

A. Yes.

Q. And you advised him to keep it a secret? I don't want to lead you. I want to be sure this is your --

A. I told Cap I can't generate paperwork.
Q. And you want to keep it a secret?
A. Well, I never used the word secret. I may have said something else but I certainly didn't say secret.
Q. Maybe that's my word, not yours. What did you tell him about spreading the word around about this project, if anything?
A. I can't remember. I just told him we couldn't generate paperwork.
Q. Did you tell him why?
A. I'm sure I told him something because Cap was the kind of guy that's going to ask you. And I don't have -- I don't know what I told him so the answer is no.
Q. Okay.
A. Or I don't remember.
Q. Whatever. But the point being you didn't want paper so other people in the company or other people would know what's going on?
A. Correct.
Q. So come back to this paragraph 11A. You don't know who was at the well site, correct?
A. That is correct.
Q. You don't know whether they were told to keep

it a secret or not?
A. No, sir.
Q. And you don't know whether they even signed something or not?
A. That's correct.
Q. And just for the record, the well sites where you're doing work is not open to the public, is it? It's a pretty dangerous environment?
A. Yeah. If you don't have any business there, they won't let you on there.
Q. So you have to be there and have a reason to be there?
A. That's correct.
Q. And they run anybody off that's not supposed to be there?
A. They will ask you to leave, yes.
Q. Do you know who the customer was?
A. No, sir.
Q. A couple of follow-ups on this two and three-eighths. Of all the work, were there any other tools at Western that you worked on other than the ones we have discussed that were composite?
A. No, sir, that was the total gambit.
Q. When you finished the field test, did you go back and report to the vice president what had happened?

A. I think he was gone. I mean, playing golf at his summer home.

Q. How much longer did you work for the company after there?

A. I don't recall.

Q. Years?

A. No. Months.

Q. So this --

A. Or maybe a year. I don't know. I would have to get my resume and all kind of stuff.

Q. Well, you've got your resume here.

THE WITNESS: Lou, you've got to help me. He's asking me a three-tiered question and I don't have a clue.

Q. (By Mr. Booth) Let me ask an easier question. When you finished -- and I guess the last thing you did on the two and three-eighths inch was when it was run down in Louisiana?

A. Okay. What I'm asking Lou to do is this, do I have a date when it was run in Louisiana, or a year.

Q. Approximately.

A. I mean, what I'm trying to say is, it's pretty evident I worked for Western based on this resume.

Q. Until '88?

A. Until '88.

Q. Okay.

A. Now, what I don't want to answer is we've talked about so many different animals here, so to speak, and dates, I don't -- you know, I'm liable to say I --

MR. STEVENS: Let's just stop right there. It's obvious that Mr. Harris is confused and he --

MR. BOOTH: I won't get into dates.

MR. STEVENS: Let's just be clear, he's trying to help but he's confused and we're not getting anything productive. So if we can do it a different way, that's fine, but we can't get to it this way.

Q. (By Mr. Booth) I'll move on. Well, two and three-eighths was the last composite project you worked on at Western?

A. That's correct, yes, sir.

Q. And it was toward the end of your employment?

A. Absolutely.

Q. Okay. And after you ran that last test, you didn't do any reports or anything, and there wasn't anybody to report to?

A. To the best of my knowledge.

Q. As far as you know you gave up on the project at that point?

A. Yes, sir. I didn't give up, I closed it.
Q. You didn't do anything more on it?
A. No.
Q. And didn't intend to?
A. No, sir.
Q. One other question. When you finished your two tests on the two and three-eighths, you told me that you had in your mind some other changes or improvements that you were going to make in the '202 to make it work. Do you recall telling me that?
A. Yes.
Q. Okay.
A. I mean, I don't --
Q. What is it that you thought that you had to do further to refine that two and three-eighths to make it a complete and workable tool?
A. Well, I can remember that because I had a little money in it, not much, and I wanted to hire a consultant that worked for Bell Helicopter in composites, because I had debt out the kazoo, to come in and tell me what I'm doing wrong with the engineering. The steel worked, the composite didn't.
Q. Right.
A. I wanted to spend the rest of that money with a consultant that could take that debt, because we spent

a lot of money on it, and me point out the areas I'm concerned about, and not only tell me what happened but what should I do, and it never happened. So I can't sit here and say I was going to change the manner where this groove is or anything like that -- I was going to get a professional consultant that's worked with composites, and Bell Helicopter had a lot of them. I wish it would have came to that point because it's a good product.

Q. You wish it would have come to the point of having some more money to do further research; is that right?

A. Yeah, or a consultant, one.

Q. To bring it to the point where you could patent it?

A. Yeah. Oh, yeah.

Q. I was looking at my notes. You mentioned the name -- let's see if this rings a bell -- that after the test you wanted to put an indention at the top where it was pulling apart?

A. Well, you're getting specific. Basically what it was, I needed more radius in the indention.

Q. Okay. And you were thinking about coming up with a way to get it molded so you could have an interior opening, correct?

A. That's correct.

Q. And the other thing is -- and I didn't understand this. I just wrote it down -- mold in slit doors and side so you could seal off the mandrel -- seal off a steel mandrel?

A. I don't recall that. I'm sorry.

Q. Mold the lug on the bottom?

A. Which tool?

Q. Two and three-eighths.

A. Yeah. What I meant there is the bottom of all retainers or plugs, there's a guide. I wanted the mandrel and that one piece -- see, when I machined them I screwed them together.

Q. The piece that's 60 in Figure 1 of the '202 patent?

A. Right.

Q. And the internal part, you wanted it one?

A. One. But you have to build a mold. So I couldn't build a mold, I didn't have that much money. So I had to take two slugs and screw them together.

Q. Okay. And to summarize the Western work, you ultimately left and didn't do any further work on it. And during the time you were at Western, as far as you know, the information about the experimental and testing program you had at Western was never published to the industry in any way?

A. I certainly think I would have known and I would say no.

Q. To your knowledge?

A. To my knowledge.

Q. In fact, to your knowledge y'all tried to keep it secret?

A. Yes, sir.

Q. Other than filing the '202 patent?

A. That's correct.

MR. BOOTH: Can I have a 10-minute break now?

(Recess held)

Q. (By Mr. Booth) Mr. Harris, I want to thank you for your time and your courtesies, and I hope I've been polite with you. Have I?

A. Oh, absolutely.

Q. I appreciate your meeting with us, like you did with Weatherford, and bringing your lawyer here to meet with us today. It's possible, Mr. Harris, that your statement would be something that would be relevant to patent procedures, and we may take this and submit it to the patent office as a statement of facts about what happened.

Is there anything that you want to add or supplement at this point? I mean, I understand you've

been under oath and you've done your best, but is there anything else or any change at this time?

THE WITNESS: Can I go off the record a minute?

(Discussion off the record)

Q. (By Mr. Booth) Do you have anything else you want to do?

A. No, John. Just thank you for giving me some breaks here because I certainly needed them, and I tried my best to -- especially dates and consequences of operation to do the best of my ability. It's a lot of people that's even in this, especially Cap, they are all dead. I mean, Western has no records so I did the best I could.

MR. BOOTH: Well, that's all we can ask. And I thank you and we can close the record.

(Signature waived)

CERTIFICATE

I, Kathy K. Elliott, Certified Shorthand Reporter in and for the State of Texas, certify that on the March 12, of 2002, I reported the sworn statement of MONTY EARLE HARRIS, after the witness had first been duly cautioned and sworn to testify under oath; said sworn statement was subsequently transcribed by me and under my supervision and contains a full, true and complete transcription of the proceedings had at said time and place.

I further certify that I am not related to or employed by any party to this action and have no interest in the outcome of same.

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